

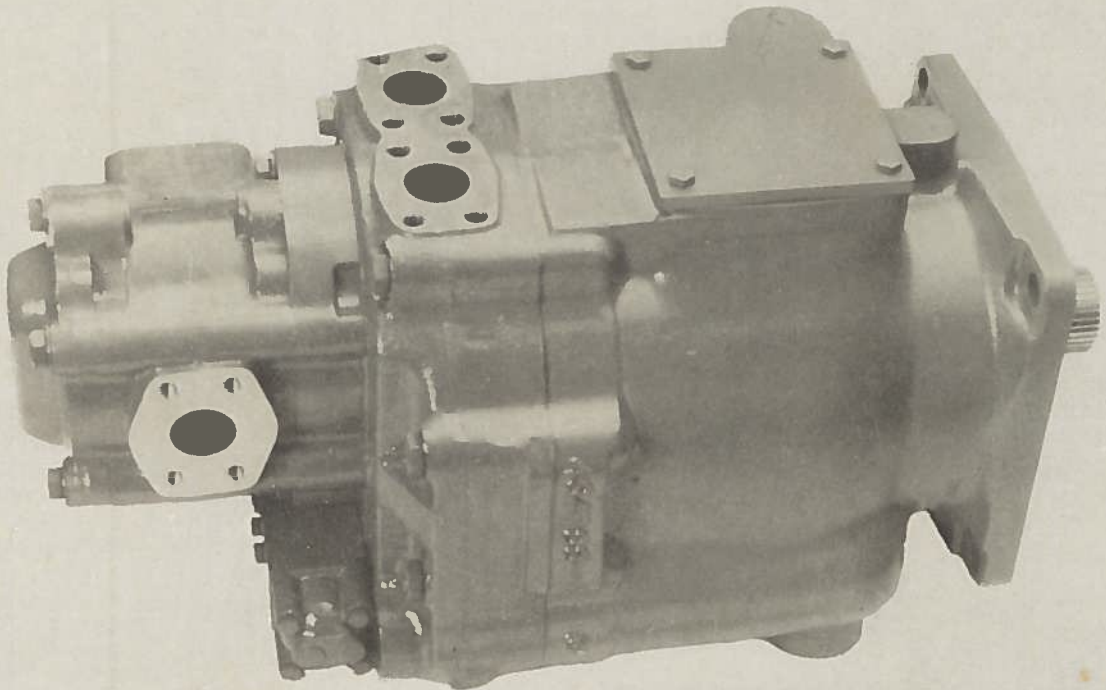
VICKERS®
A TRIMMOVA COMPANY

Service Parts Information

HEAVY DUTY
PISTON PUMP

PVD80C-**-**-12-C**-14

10

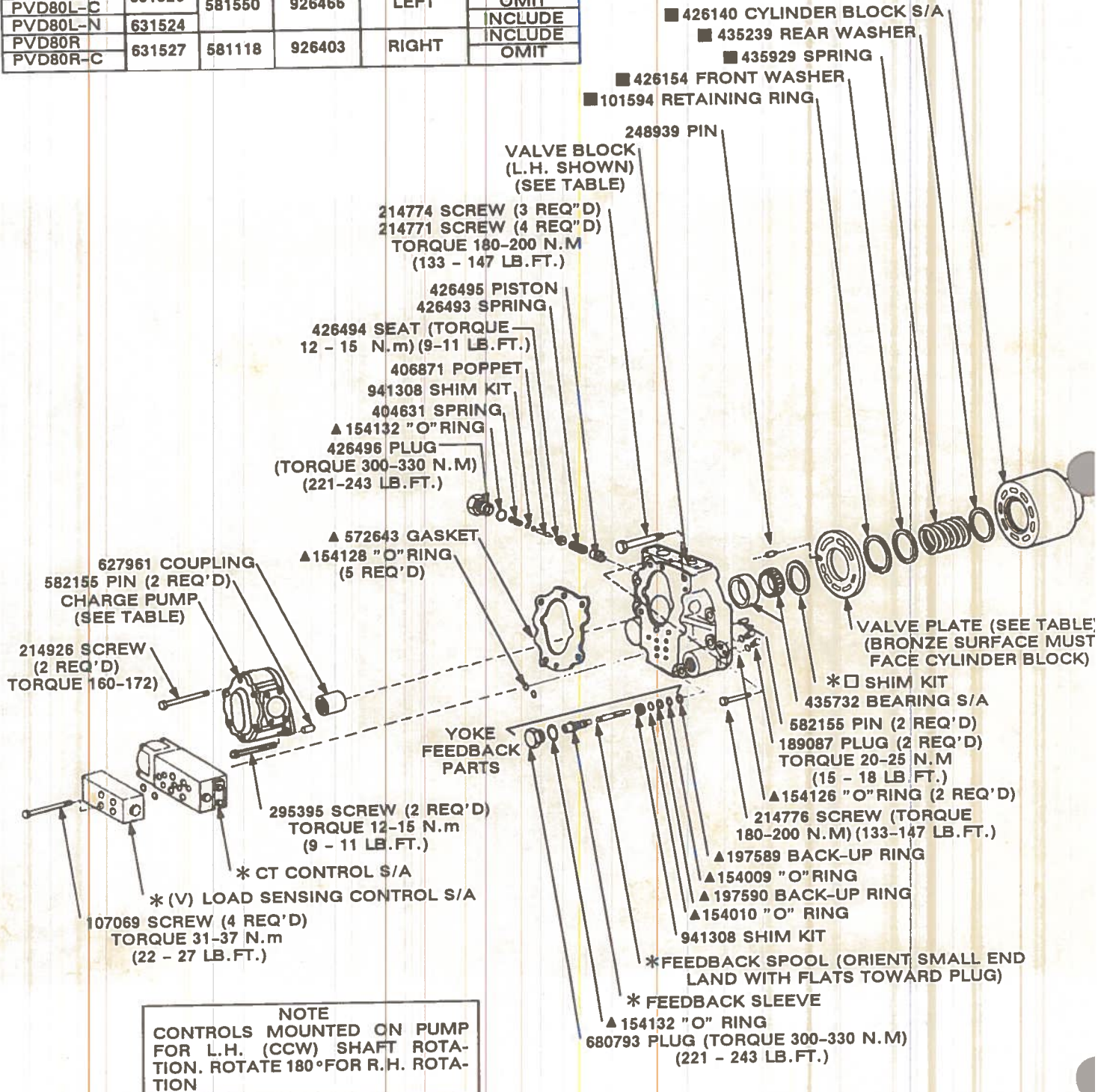


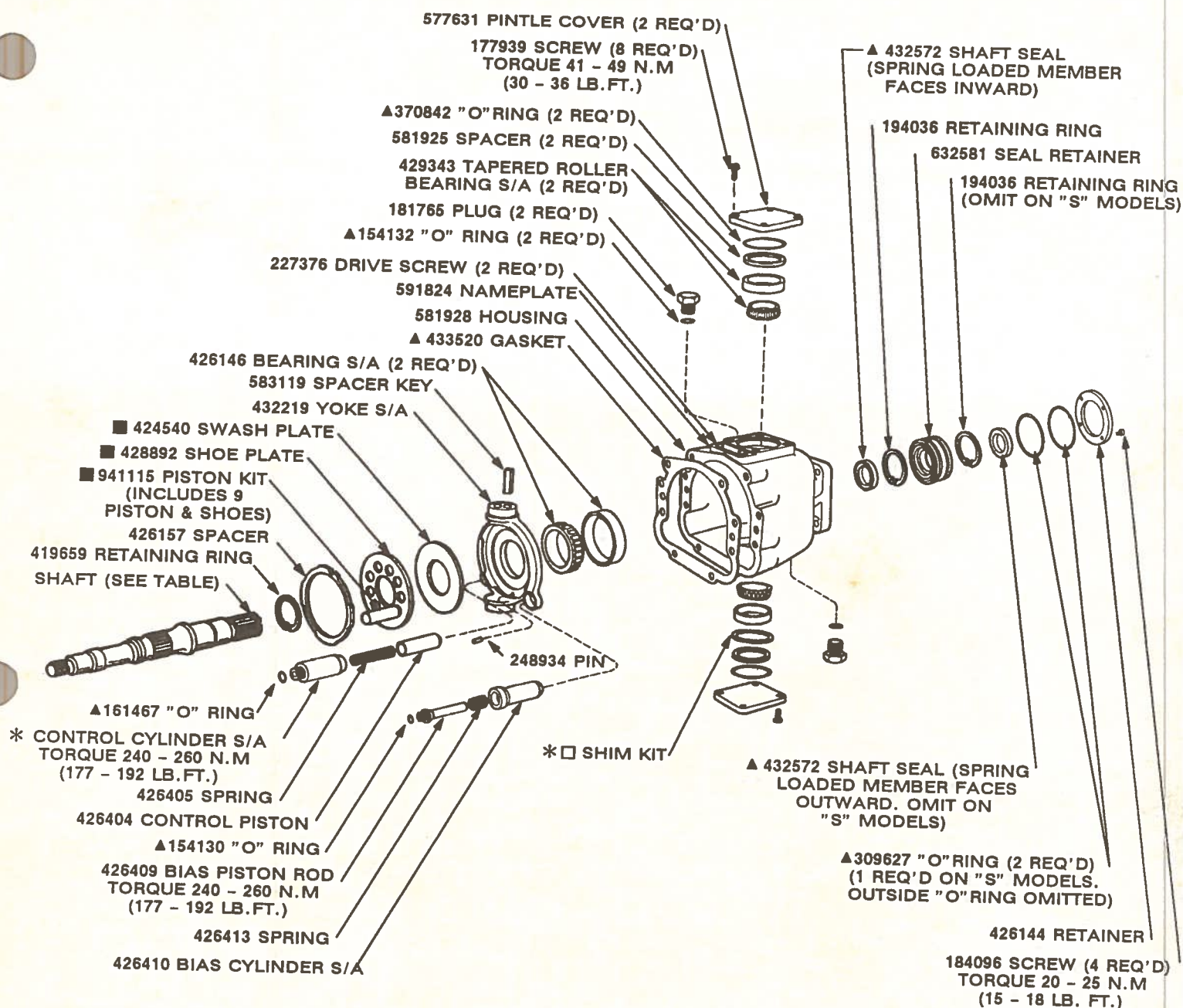
Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Released 12-1-88 M-2225-S

MODEL	VALVE BLOCK	VALVE PLATE	CHARGE PUMP KIT	ROTATION DIRECTION	YOKE FEEDBACK PARTS
PVD80L	631526	581550	926466	LEFT	INCLUDE
PVD80L-C					OMIT
PVD80L-N	631524	581118	926403	RIGHT	INCLUDE
PVD80R	631527				INCLUDE
PVD80R-C					OMIT





MODEL	SHAFT
PVD80-1*	632577
PVD80-6*	632578
PVD80-9*	632579

- ▲ INCLUDED IN SEAL KIT 920374
F3 EQUIVALENT 920308
- INCLUDED IN 926485 SHIM KIT
- INCLUDED IN 938079 ROTATING GROUP

*** NOTE**
 REFER TO OVERHAUL MANUAL M-2231-S FOR
 CONTROL INFORMATION, FEEDBACK SPOOL
 & SLEEVE NUMBERS AND CHARGE RELIEF &
 YOKE SHIMMING PROCEDURE

NOTE
 REFER TO OVERHAUL MANUAL M-2230-S FOR
 SHAFT END PLAY & PINTLE BEARING SHIM-
 MING PROCEDURES.

P V D 80 C * - * * - 12 - C - 14**
1 2 3 4 5 6 7 8 9 10 11

SHAFT END PLAY SHIMMING PROCEDURE

1. INSTALL BEARING S/A ON END OF SHAFT WITHOUT SHIM. INSTALL VALVE BLOCK ON HOUSING AND SECURE WITH SEVEN SCREWS.
2. ROTATE THE SHAFT. APPLY 1110-1330 N.m (250-299 LBF) FORCE AT END OF SHAFT TO SEAT SHAFT BEARING.
3. MEASURE SHAFT END PLAY WITH A DIAL INDICATOR.
4. REMOVE VALVE BLOCK AND BEARING S/A FROM UNIT. INSTALL SHIMS TO END OF SHAFT TO PROVIDE .025-.102 MM (.001-.004 INCH) SHAFT END PLAY.
5. INSTALL BEARING S/A ON END OF SHAFT. INSTALL THE VALVE BLOCK AND SECURE WITH SEVEN SCREWS.
6. REPEAT STEP 3.

1. INSTALL BOTH PINTLE BEARING COVERS ON THE YOKE S/A
2. INSTALL COMPLETE PINTLE ASSEMBLY (INCLUDES BEARING RACE, SPACER, 'O'RING, PINTLE COVER AND SLEEVES) AT TOP OF HOUSING.
3. INSTALL THE OTHER BEARING RACE. INSTALL SHIM. (APPROXIMATELY .40 MM) AND SPACER SO THAT THE SPACER PROTRUDES .25-MM (.001 - .015 INCH) ABOVE THE HOUSING FACE.
4. MOVE THE YOKE S/A BACK AND FORTH. APPLY 1110-1330 N (250-299 LBF) FORCE TO THE SPACER TO SEAT THE PINTLE BEARINGS.
5. MEASURE THE DISTANCE FROM FACE OF HOUSING TO THE TOP OF SPACER.
6. REMOVE THE SPACER. REMOVE THE AMOUNT OF SHIMS EQUAL TO THE MEASUREMENT FOUND IN STEP 5.
7. ADD .381 - .483 MM (.015-.019 INCH) SHIM THICKNESS TO THE SHIM STACK FOUND IN STEP 6. ASSEMBLE THE SPACER.
8. INSTALL 'O'RING, PINTLE COVER AND SCREWS TO COMPLETE THE PINTLE ASSEMBLY.

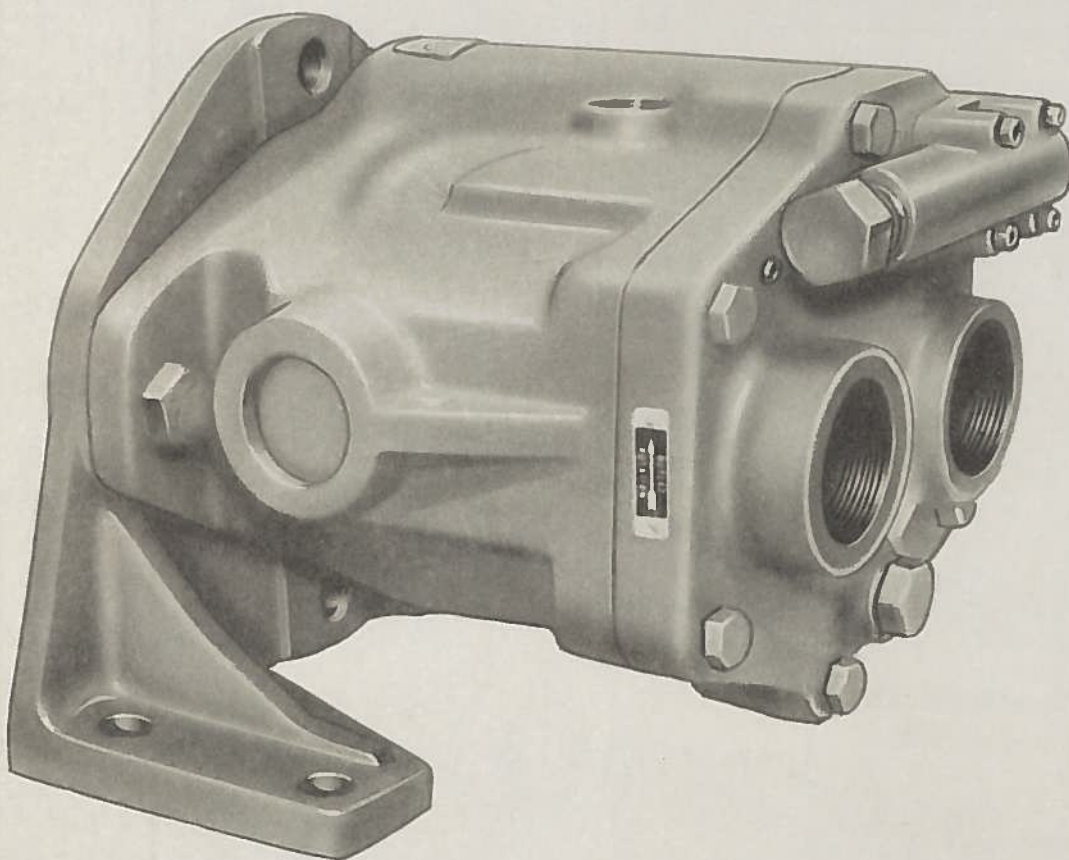
Litho in U.S.A.

Service Parts Information

**20 & 29 GPM
Variable
Inline
Piston
Pumps**

PVB20-*S-20-*(*)-(*)-11
PVB29-*S-20-*(*)-(*)-11

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Vickers, Incorporated

P.O. Box 302
Troy, Michigan 48007-0302

Revised 12-1-87

I-3267-S

● INCLUDED IN PRESSURE
COMPENSATOR SUBASSYS
SHOWN IN TABLE.

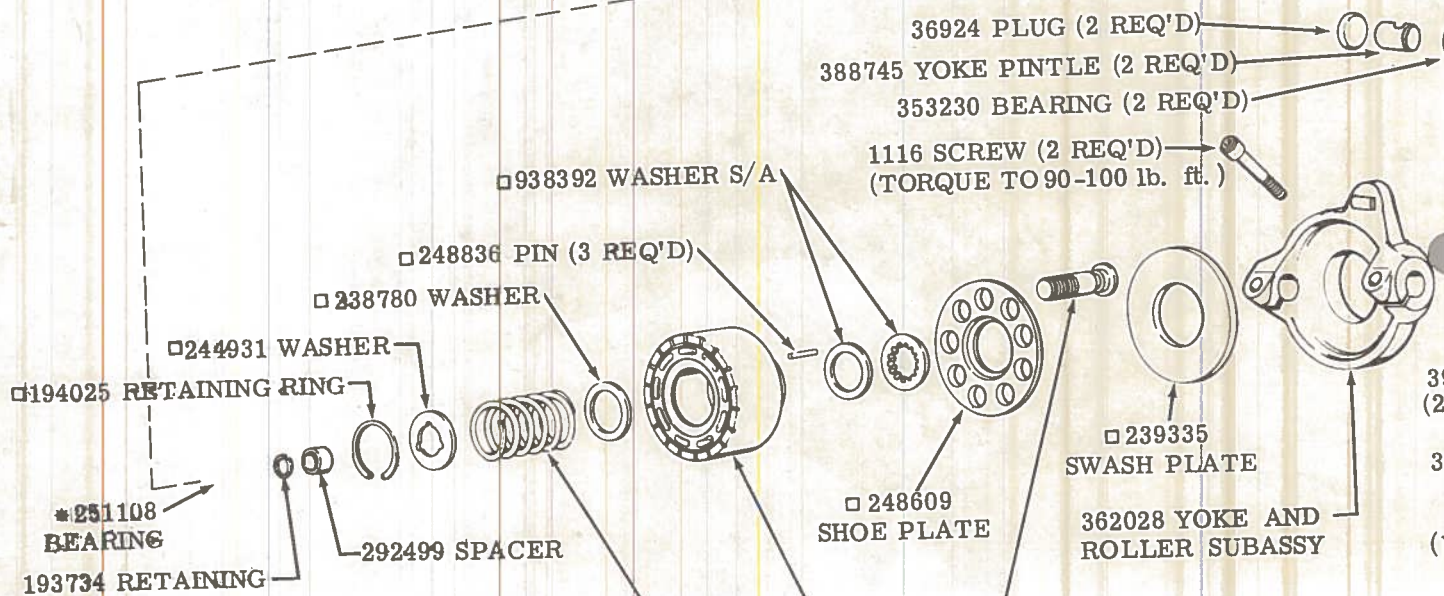
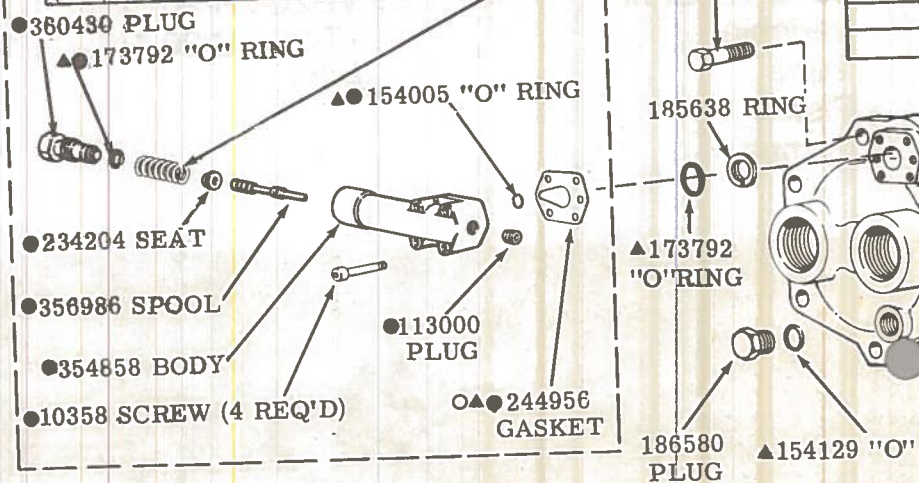
PRESSURE RANGE (PSI)	COMPEN- SATOR SUBASSY	SPRING
(C) 250-2500 (20) 250-2000 (29)	942158	239371 ●
(CM) 250-1500	942159	265693 ●

CAUTION
POSITION GASKET WITH SMALL END
OF TEARDROP HOLE POINTING IN
DIRECTION OF COMPENSATOR ADJ-
USTING PLUG.

▲ INCLUDED IN
919683 SEAL KIT

F3 EQUIVALENT
919847 SEAL KIT

NOTE: TYPE 'C' & 'CM' COMPENSATOR CONTROL
PARTS SHOWN. REFER TO PARTS DRWG. I-3243-S
FOR 'CVP' PRESSURE LIMITER & LOAD SENSING
COMPENSATOR CONTROL.



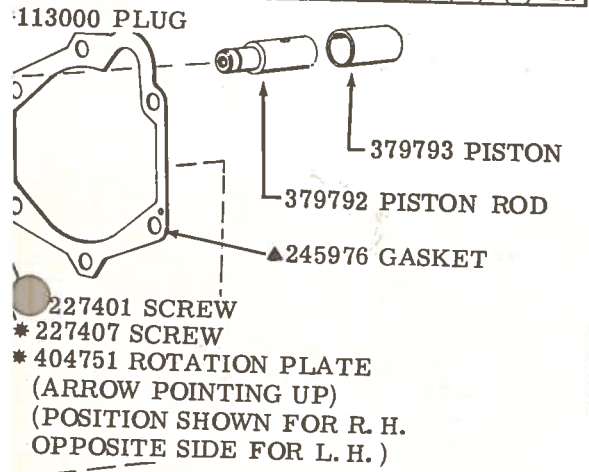
MODEL	SPRING	CYLINDER BLOCK	PISTON SUBASSY KIT	ROTATING GROUP
PVB20-(F)*S-20-C(M)-(*)-11	246386	250688	941883	938274
PVB29-(F)*S-20-C(M)-(*)-11	263582	259458	941888	938275

■ INCLUDES 9
PISTON & SHOE S/A

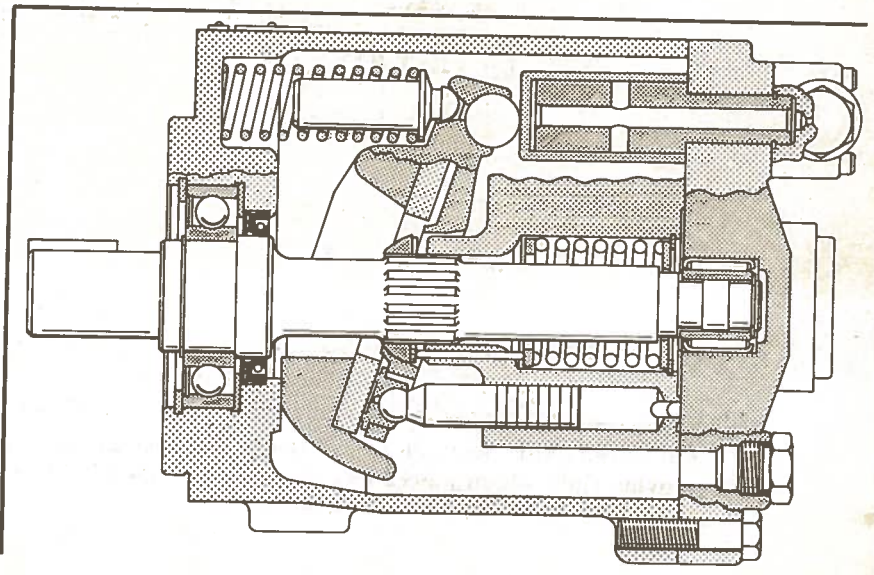
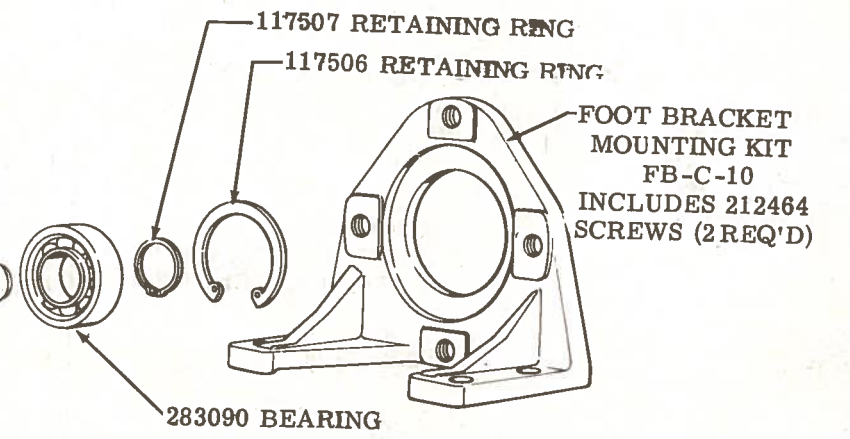
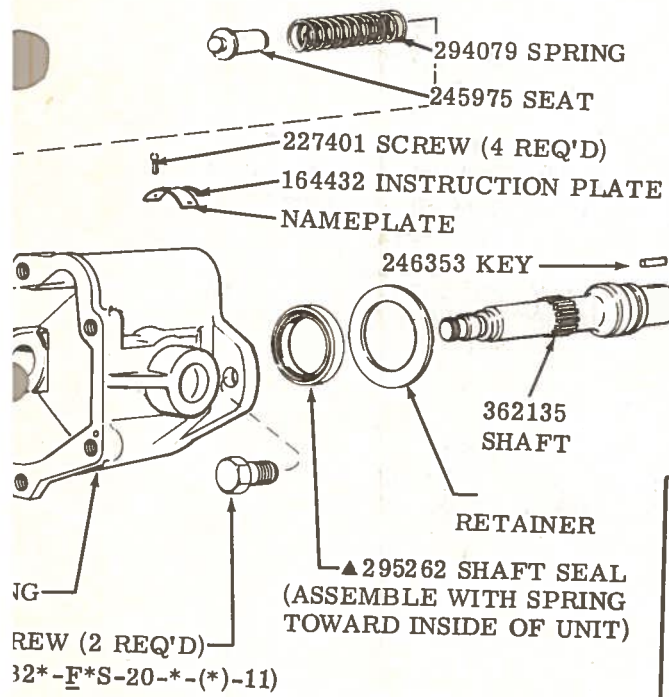
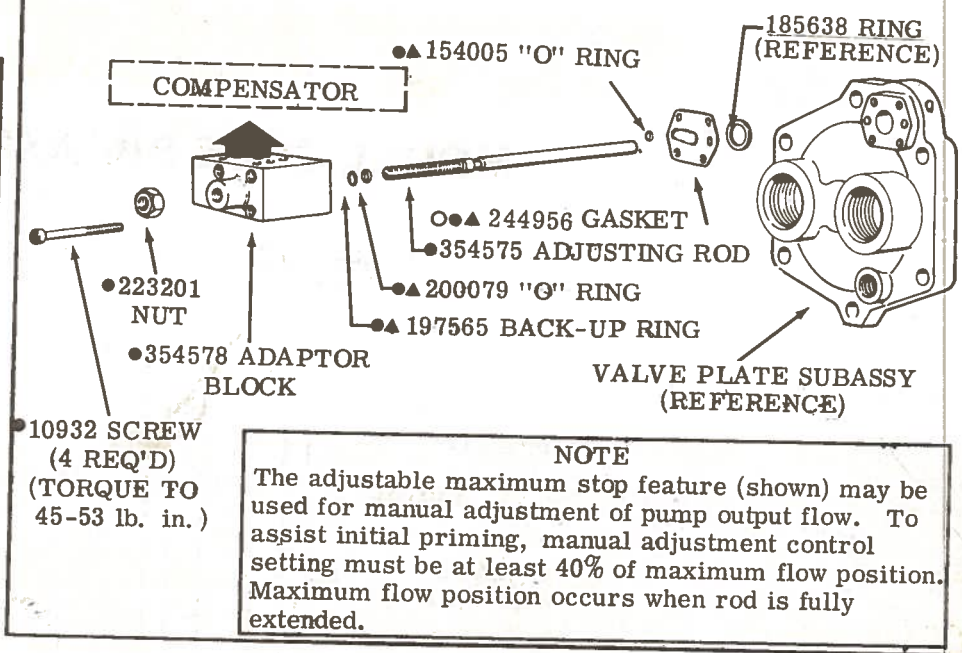
□ INCLUDED IN
ROTATING GROUP



DED IN TE SUBASSY	MODEL
169	PVB20-(F)RS-20-C(M)-(*)-11
170	PVB20-(F)LS-20-C(M)-(*)-11
171	PVB29-(F)RS-20-C(M)-(*)-11
172	PVB29-(F)LS-20-C(M)-(*)-11

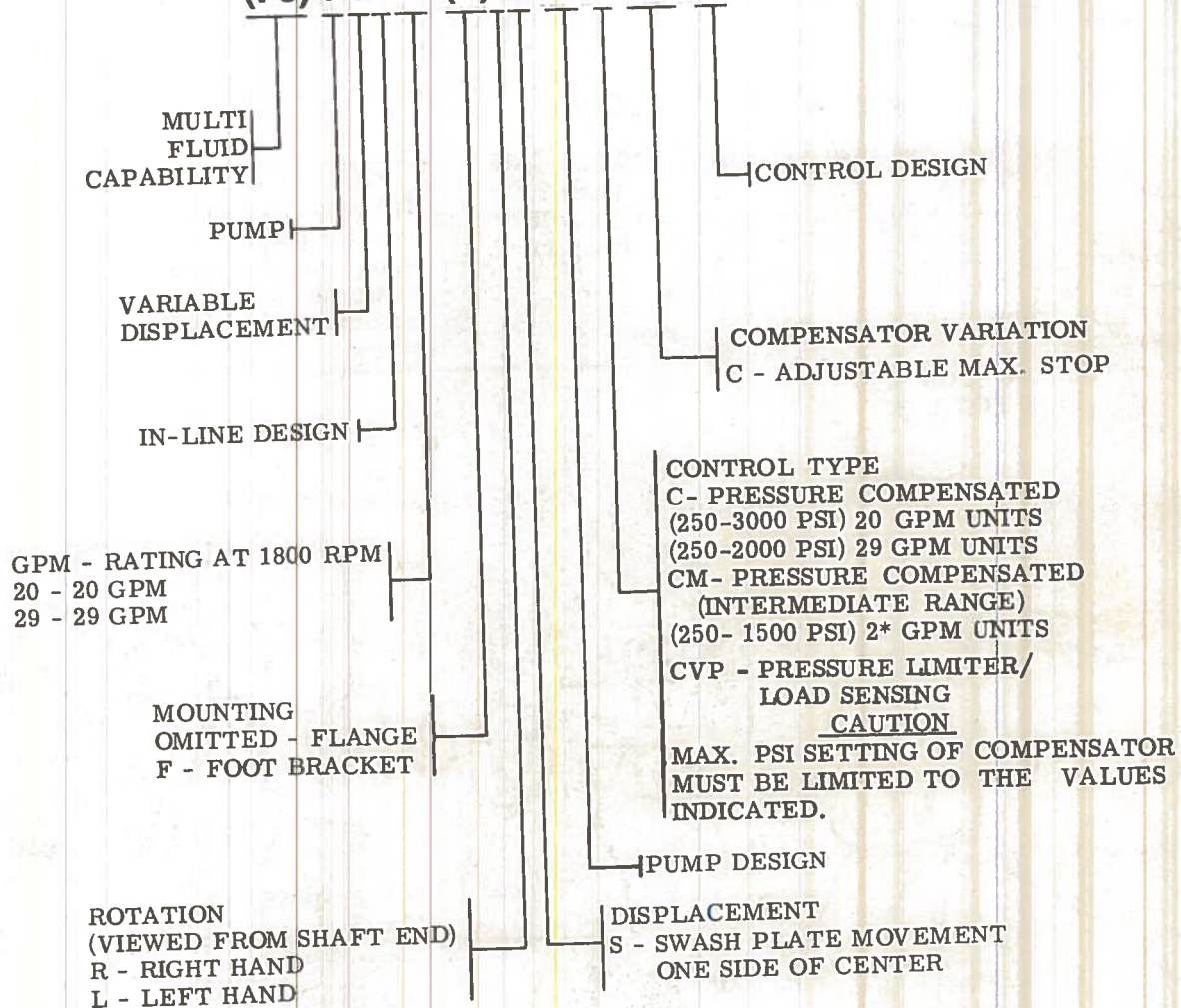


• INCLUDED IN ADJUSTABLE
MAXIMUM STOP SUBASSY 942192.



MODEL CODE BREAKDOWN

(F3)-PVB2*-(F)*S-20*-(C)-11



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.



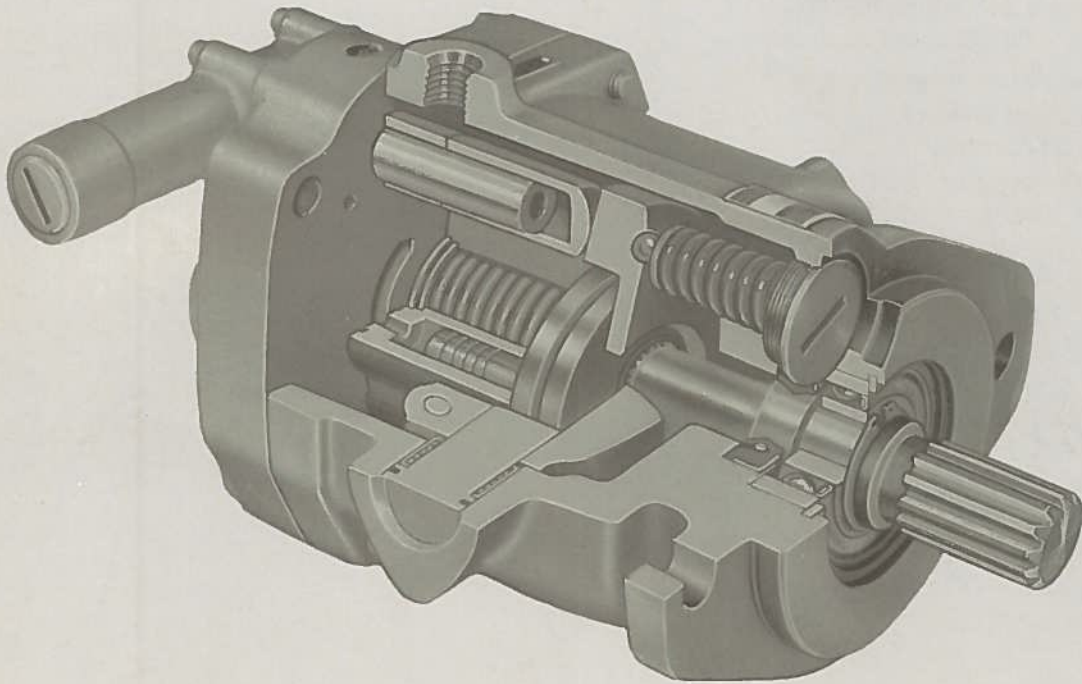
Service Parts Information

Variable
Inline
Piston
Pumps

M-PVB29 - 11 Design

20

DUP



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1401 Crooks Road
Troy, Michigan 48064

Revised 12-1-87

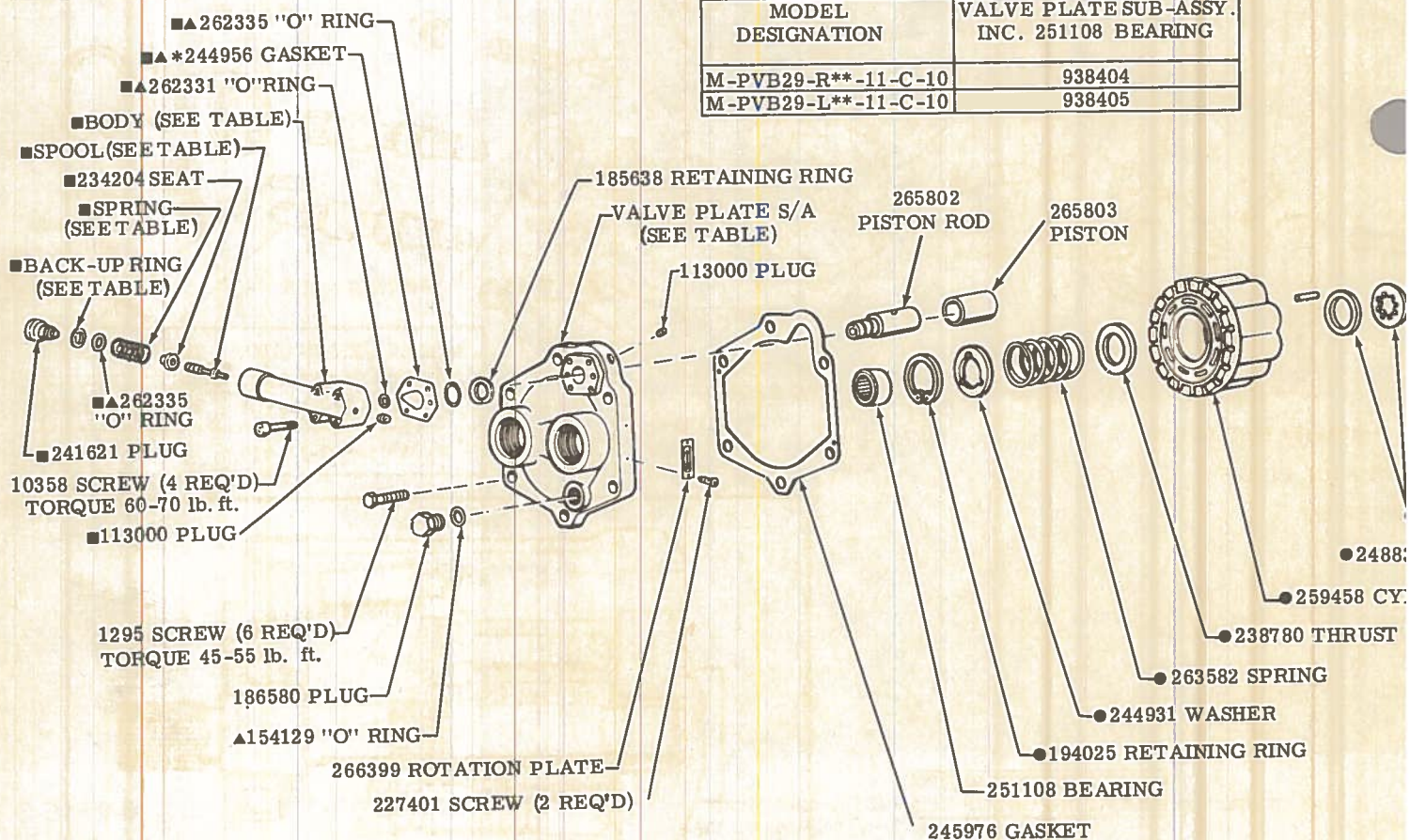
M-2215-S

CONTROL TYPE	BODY	SPOOL	BACK-UP RING	PLUG	WIRE	SEAL	SPRING	COMP. KIT
C	241568	241717		241621				941700
CR		285624					239371	923990
CG	412890	296234	197573	412940	17077	17079		942480
CV		278711					417649	942441

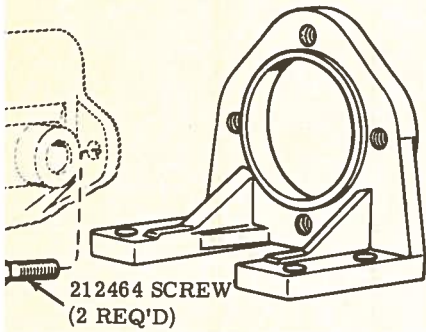
■ INCLUDED IN COMPENSATOR KIT

***CAUTION**
POSITION GASKET WITH SMALL END OF
TEARDROP HOLE POINTING IN DIREC-
TION OF COMPENSATOR ADJUSTING
PLUG.

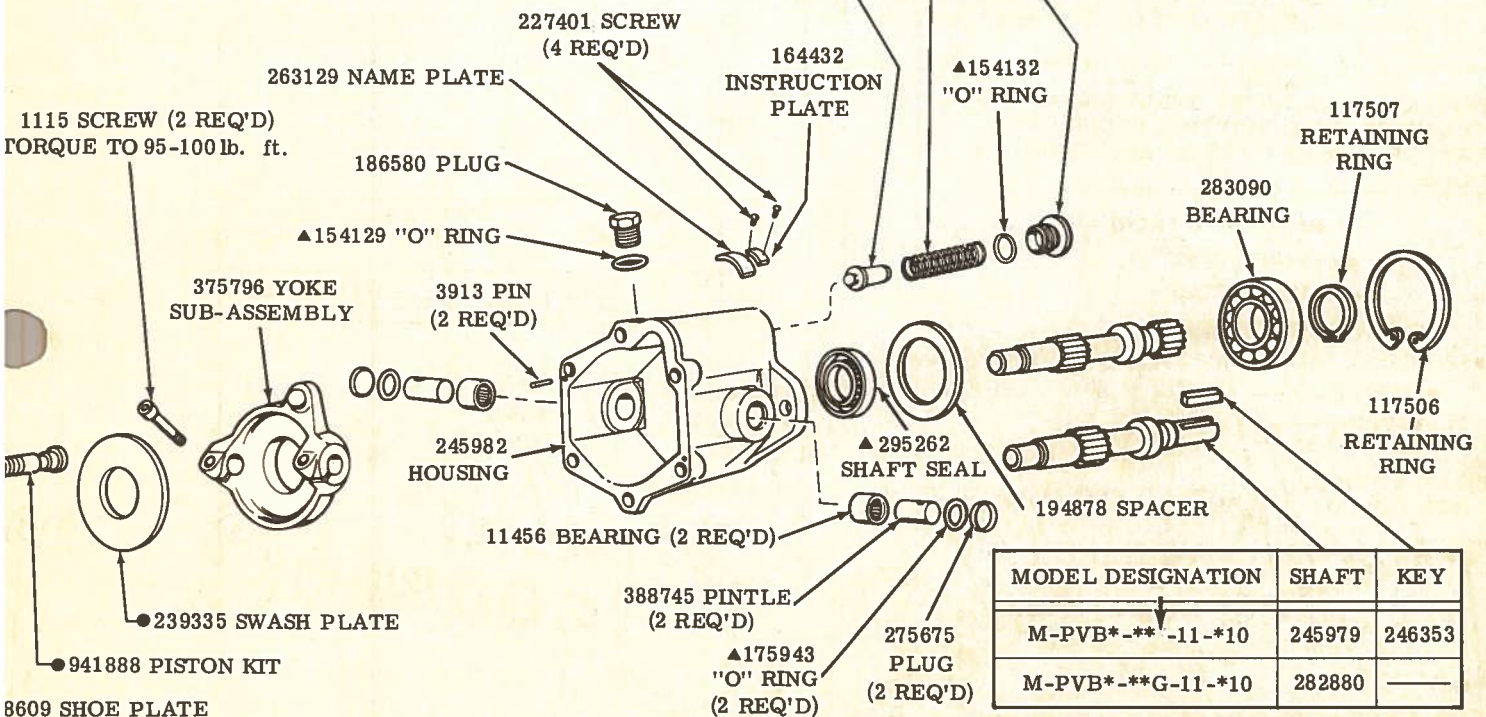
MODEL DESIGNATION	VALVE PLATE SUB-ASSY. INC. 251108 BEARING
M-PVB29-R**-11-C-10	938404
M-PVB29-L**-11-C-10	938405



**HOIST MOUNTING KIT
C-10 (INCLUDES SCREWS)**



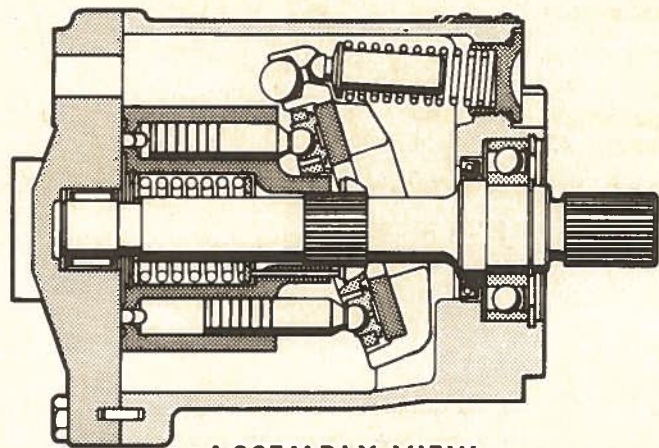
SEAT	SPRING	PLUG	MODEL DESCRIPTION
245975	436335	245973	M-PVB29-***-11-C-10
245975	436335	245973	M-PVB29-***-11-CG-10
306370	306434	306369	M-PVB29-***-11-CR-10
245975	436335	245973	M-PVB29-***-11-CV-10



MODEL DESIGNATION	SHAFT	KEY
M-PVB*-**-11-*10	245979	246353
M-PVB*-**G-11-*10	282880	—

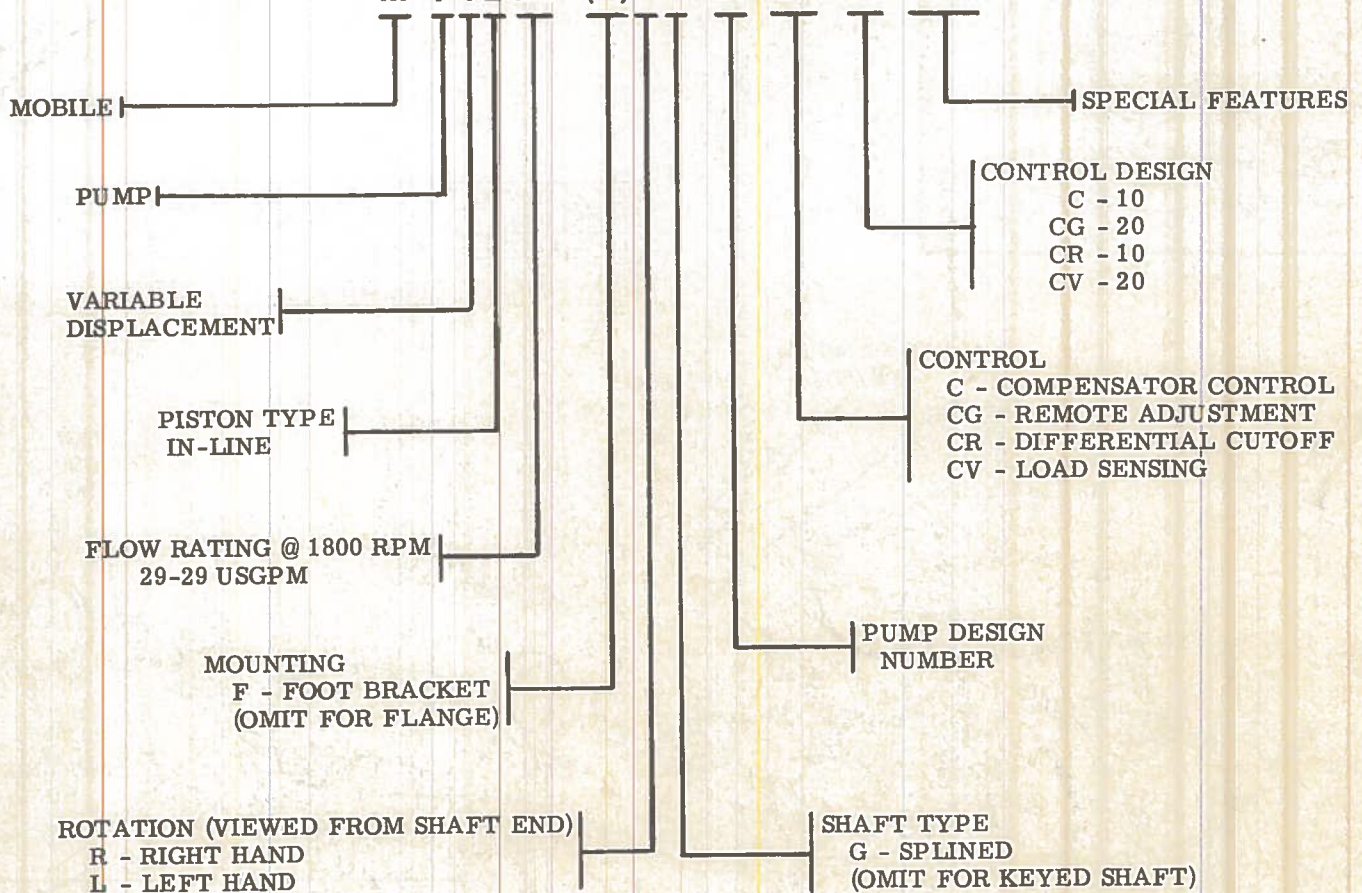
● INCLUDED IN 938290
ROTATING GROUP KIT

▲ = SERVICED IN 923006 SEAL KIT



MODEL CODE BREAKDOWN

M-PVB 29-(*) -11-C*-0-*****



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U.S.A.

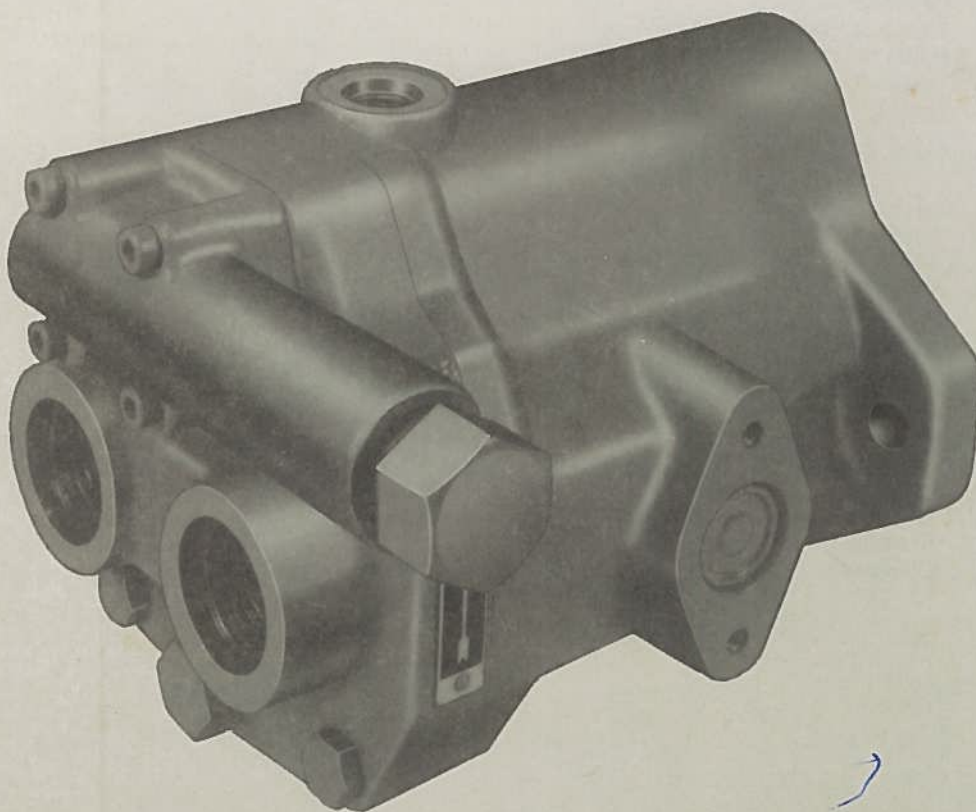
VICKERS®
A TRIMOVA COMPANY

Overhaul Manual

**Fixed & Variable
Displacement
Inline Piston
Pumps & Motors**

MFB Series
MVB Series
P(M)FB Series
P(M)VB Series

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Vickers, Incorporated

P.O. Box 302
Troy, Michigan 48007-0302

Revised 7-1-86

I-3230-S

SECTION

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Section I - INTRODUCTION

A. PURPOSE OF MANUAL

This manual describes operational characteristics and overhaul information for the fixed and variable delivery inline piston type pumps and motors. The information contained herein pertains to the latest design series.

any Vickers sales representative or from:

Vickers, Incorporated
Technical Publications
1401 Crooks Road
Troy, Michigan 48084

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts and installation drawings listed in Table 1 are available

2. Model Codes - Variations within each basic model series are covered in the model code. Table 2 is a complete breakdown of the codes covering these units. Service inquiries should always include the complete unit model code number as stamped on nameplate located on housing.

MODEL	INSTALLATION DRAWING	PARTS DRAWING
M-MFB5	289420	I-3238-S
MFB5	520300	I-3238-S
MFB10	000324	I-3244-S
M-MFB15	000324	M-2765-S
M-MFB20	289420	M-2763-S
MFB20	000324	I-3247-S
M-MFB29	000324	M-2763-S
MFB29	520310	I-3741-S
MVB5	273831	I-3280-S
MVB10	273838	I-3268-S
M-MVB29	000324	M-2773-S
M-PFB5	289424	I-3238-S
PFB5	507725	I-3238-S
M-PFB10	289419	M-2202-S
PFB10	507727	I-3244-S
M-PFB15	289419	M-2202-S
M-PFB20	289426	M-2203-S
PFB20	507729	I-3247-S
M-PFB29	289426	M-2203-S
PVB5	508300	I-3280-S
PVB6	508300	I-3280-S
PVB6A	508275	I-3281-S
M-PVB10	289419	M-2212-S
PVB10	508400	I-3268-S
M-PVB15	000324	M-2212-S
PVB15	508400	I-3268-S
M-PVB20	000324	M-2213-S
PVB20	508500	I-3267-S
M-PVB29	000324	M-2213-S
PVB29	508500	I-3267-S
PVB45A	508890	I-3294-S

Table 1. Reference Material

MODEL CODE BREAKDOWN

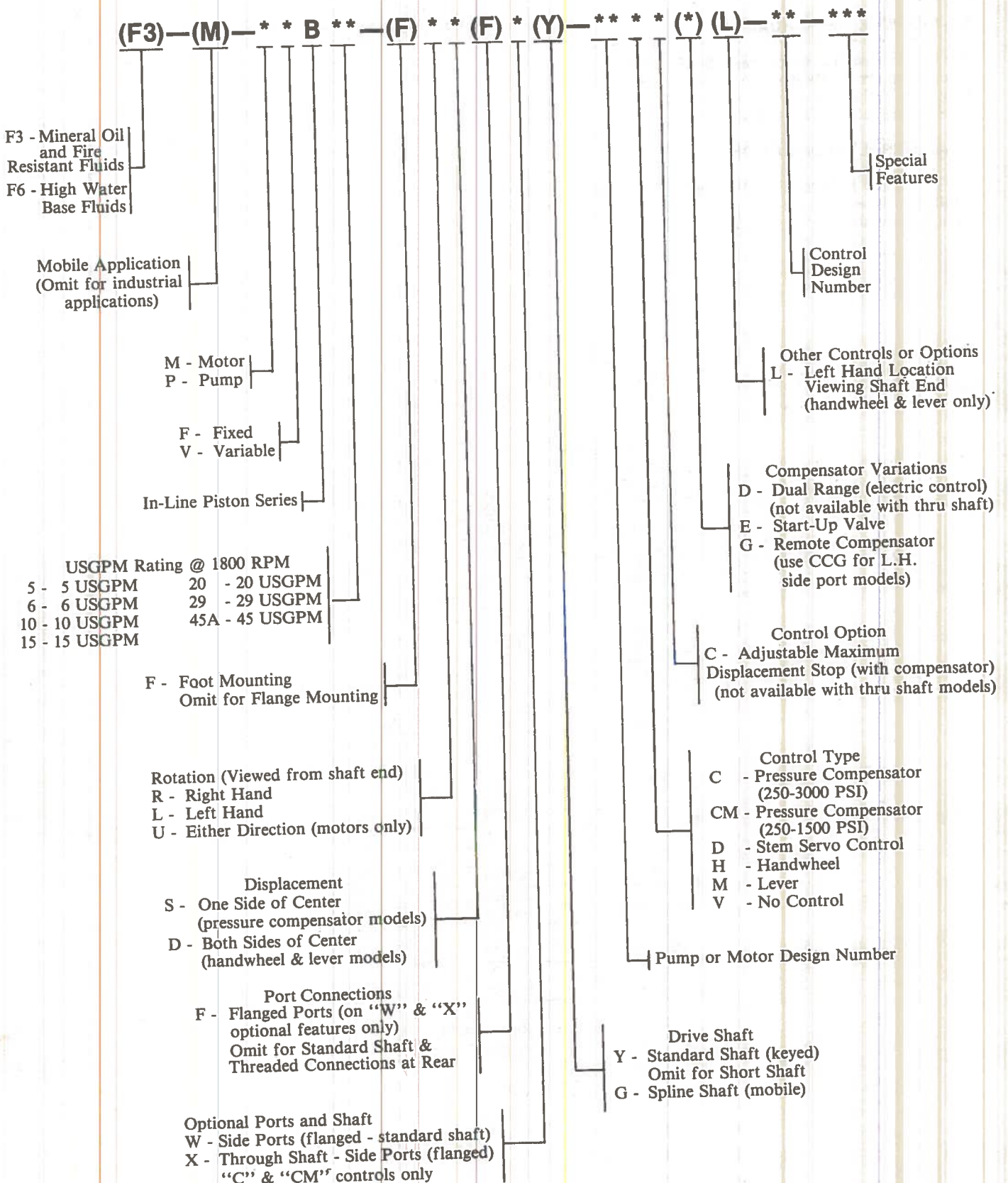


Table 2. Model Code Breakdown

Section II - DESCRIPTION

A. GENERAL

Vickers inline pumps and motors are of the axial piston, positive displacement type and include both fixed and adjustable (variable) displacement pumps and motors capable of high pressure operation. Drive speeds vary with the model, type of fluid used, and circuit application.

B. ASSEMBLY AND CONSTRUCTION

The assembly of typical fixed and variable displacement units

together with their A.N.S.I. symbols are shown in Figure 1. As illustrated, the major components of the inline unit are the housing, bearing-supported drive shaft, rotating group, swash plate and valve plate. The pressure compensated variable displacement units incorporate a pressure sensitive control piston, which governs the angle of the yoke and swash plate and consequently controls the stroke length of each piston as it rotates with the cylinder block and drive shaft. The valve plate subassembly also serves as the back cover of the entire unit and includes the inlet and outlet ports. A bearing in this cover and one in the housing support the drive shaft.

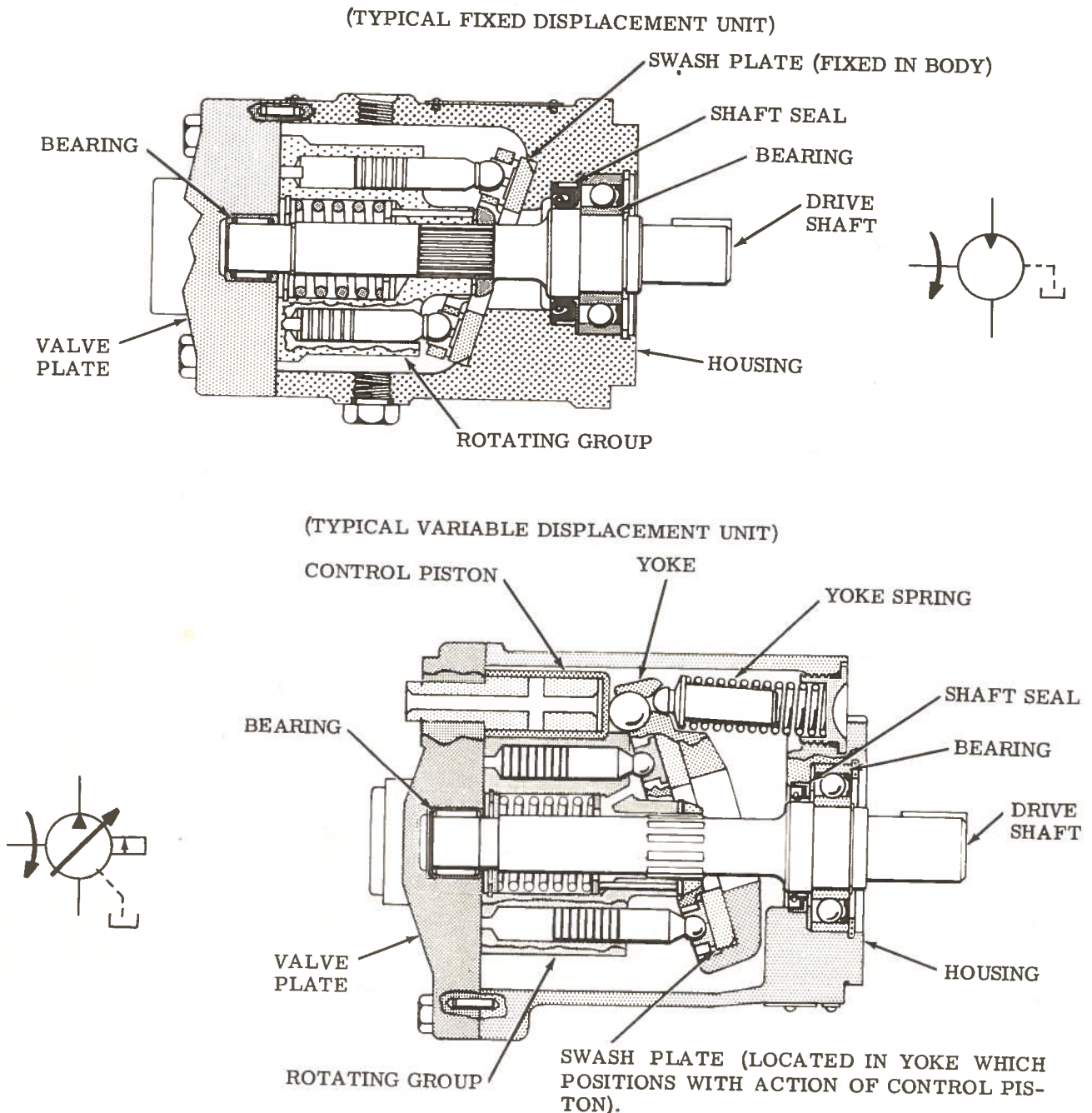


Figure 1. Typical Unit Assembly.

Section III - PRINCIPLES OF OPERATION

A. GENERAL

Although nearly identical in design, pumps and motors operate essentially in reverse of each other – the pump forcing fluid through the system as it rotates, the motor being rotated by the fluid. Variable displacement units are constructed so that the angle of displacement (angle of the swash plate to the drive shaft axis) can be varied by changing the yoke position.

B. MOTORS

Motors are positive displacement units which are capable of producing a variable torque and speed. Motor speed is a function of the input fluid volume and torque is a function of the input pressure. On a variable displacement motor, the angle of displacement (swash plate angle) also affects the speed and torque.

In operation, pressurized fluid is forced into the cylinder block bores which are open to the inlet port. Inlet pressure causes the pistons to exert a force against the swash plate. At the control point of the piston shoe and swash plate, a component of the angular counter-force causes the cylinder block to move in a rotary direction. The remaining cylinder block bores are either open to the outlet or blocked by the valve plate. When the pistons move across the outlet port, fluid discharges and returns to the reservoir or system.

Rotation is reversed by reversing the fluid supply to the motor or if the motor is a variable displacement type, it can be stroked across-center for reversal. If a variable unit is stroked across center, adequate precautions must be taken to prevent overspeed, overpressure and/or cavitation. "Stroking across center" means moving the swash plate from an angle on one side of center, to zero (center) angle of the yoke, and then to the opposite side of center.

Motors are used for continuous, intermittent, or continuously reversing service. They can be stalled indefinitely under load without damage when protected by a relief valve.

C. PUMPS

The operation of the pump is essentially in reverse of motor operation. During the time that a piston is moving out of the cylinder block bore, a pressure differential develops which forces fluid into the open cylinder block bores through the inlet port. As the cylinder block rotates past the outlet port, the pistons force fluid out into the system.

On variable displacement pumps, outlet volume is varied by changing the swash plate angle between the swash plate and the drive shaft axis. Since the swash plate angle is not variable on fixed displacement pumps, the flow is determined by pump size and speed driven (RPM).

Section IV - INSTALLATION

A. GENERAL

Installation drawings shown in Table 1 should be consulted for correct installation information.

B. MOUNTING AND DRIVE CONNECTIONS

CAUTION

Pump/motor shafts are designed to be installed in couplings with a slip fit. Pounding can injure the bearings. Shaft tolerances are shown on the installation drawings. (See Table 1.)

A pilot on the pump/motor mounting flange assures correct mounting and shaft alignment. Make sure the pilot is firmly seated in the accessory pad of the power source. Care should be exercised in tightening the mounting screws to prevent misalignment.

Mount the unit with the drain line connection at the top. This will allow easy filling of the housing before start-up and also prevent draining of the housing in periods of idleness. There should be no restriction between the drain port and the reservoir. The drain line must terminate below reservoir fluid level.

C. INLET LINE

Inlet lines must have sufficient capacity to allow full flow requirements at the pump or motor inlet for all conditions of operation. The use of restrictive inlet tubing, undersize filter or an improper grade of fluid may result in inlet vacuum conditions exceeding the recommended five inches of mercury and cause cavitation in pumps. Cavitation is the rapid formation

and collapse of vapor pockets within the fluid and can cause excessive damage to the unit. Motor inlet lines must be of the high pressure type to withstand the output pressure of the associated pump. Check the appropriate installation drawing for maximum motor/pump speed. (See Table 1.)

D. FILTRATION

Vickers recommends the use of inlet, pressure and/or return line filtration. Inlet filters can be supplied with magnets and a contamination indicator or an electrical switch. The electrical switch feature can be used to actuate an alarm when the filter element is plugged. Vickers field engineering personnel should be consulted when unusual fluids or viscosity conditions are encountered.

E. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sandblasting, wire brushing and pickling.

NOTE

For instructions on pickling, refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

F. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components with particular emphasis on hydraulic pumps and motors. Any oil selected for use with pumps is acceptable for use with valves or motors.

Data sheet I-286-S for oil selection is available from Vickers Technical Publications, Troy, Michigan 48084.

Oil recommendations noted in the data sheet is based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers sales engineer.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean.

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.
2. Filter each change of oil to prevent introduction of contaminants into the system.
3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.
4. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.
5. During usage, proper oil filling and servicing of oil filters, breathers, reservoirs, etc., cannot be over emphasized.
6. Thorough precautions should be taken by proper system and reservoir design, to insure that aeration of the oil will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause the loudest noises in hydraulic systems are:

1. Very high viscosities at start-up temperatures can cause noises due to cavitation.
2. Running with a moderately high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.
3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity in discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

G. OVERLOAD PROTECTION

Both fixed and compensated pumps require an external relief valve to provide maximum protection of circuit components. An external relief valve is also required in the inlet line of a hydraulic motor to limit the pressure and torque.

H. STARTING AND PRIMING

Before initial starting, fill the housing with clean fluid. Normal "leakage" past the pistons or between the cylinder block and valve plate provides internal lubrication of working parts. To assure initial priming of variable displacement units, adjust the controls to provide at least 40% of maximum displacement at start-up. The control may be reset to a lower displacement after priming is accomplished.

It may be necessary to bleed air from the pump outlet line to permit priming and reduce noise. Bleeding may be accomplished by loosening an outlet connection until a solid stream of fluid appears. An automatic air bleed valve (ABT-02-10) can be permanently installed and will eliminate the necessity to loosen a connection.

Section V - SERVICE AND MAINTENANCE

A. SERVICE TOOLS

The following standard tools are required for overhaul of a piston type pump or motor:

1. Torque wrench with socket adapters
2. Set of U.S. hex key wrenches
3. Set of small pin punches
4. 3/8 inch socket set with ratchet
5. Small ball peen hammer
6. Steel scale
7. Micrometer (0-1 inch)
8. Dial indicator

An arbor press is also required for assembly of shaft and pintle bearings.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be cleaned regularly:

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants. If the fluid becomes contaminated, the system should be drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher than normal pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the bypass to open, resulting in a partial or complete loss of filtration.

4. Air bubbles in the reservoir can ruin the pump and other components. If bubbles are seen, locate the source of the air and seal the leak.

5. A pump or motor which is running excessively hot or noisy is a potential failure. Should a unit become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer) or preferably pumped through a 10 micron (absolute) filter.

It is important that the fluid be clean and free of any substance

which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint from getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of shaft couplings should be as specified by their manufacturers.

F. REPLACEMENT PARTS

Reliable operation through the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and materials are used in the manufacture of our parts. Substitutions may result in early failure. Part numbers are shown in the parts drawings listed in Table 1.

G. TROUBLESHOOTING

Table 3 lists the common difficulties experienced with piston pumps and motors. It also indicates probable causes and remedies for each of the troubles listed.

Section VI - OVERHAUL

A. GENERAL

CAUTION

Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators, and block any load whose movement could generate pressure.

After removing pump or motor from system and before disassembly, cap or plug all ports and disconnected lines. Clean the outside of the unit thoroughly to prevent entry of dirt into the system.

CAUTION

Absolute cleanliness is essential when working on a hydraulic system. Always work in a clean area. The presence of dirt and foreign materials in the system can result in serious damage or inadequate operation.

NOTE

Discard and replace all "O" rings, gaskets and shaft seals removed during disassembly.

B. DISASSEMBLY

All models are disassembled in the same general sequence as shown in the exploded view, Figure 2.

NOTE

This procedure is written for a basic compensator model. If a control other than a compensator is used, refer to the appropriate service parts drawing for information on the control.

Parts should be placed on a clean piece of Kraft paper in the order of disassembly.

1. Remove four screws (1) from compensator body (2).
2. Remove compensator body (2) from valve plate subassembly (7).
3. Remove gasket (3), "O" ring (4) and retaining ring (5) from piston rod (9).
4. Remove six screws (6) from valve plate subassembly (7).
5. Remove valve plate subassembly (7) from housing (36). Place valve plate subassembly on a clean piece of Kraft paper with machined surface up. Remove piston rod (9), spacer (10) and piston (11) from valve plate (7). (Note: Spacer does not exist in all models.)
6. Remove gasket (8) and discard.

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	Reservoir fluid level low. Intake filter or pipe plugged. Air leak in intake line prevents priming. Coupling or shaft sheared or disengaged. Pump driven in wrong direction of shaft rotation.	Add fluid and check level on both sides of reservoir baffle to insure pump intake line is submerged. Clean filters of lint soon after new fluid is added. Pour fluid on intake joints while listening for change in sound of operation. Tighten as required. Disassemble pump and check shaft and rotating group for damage. Replace necessary parts. Check installation. Reverse the drive or convert pump as discussed in the overhaul section.
SYSTEM NOT DEVELOPING PRESSURE	Contamination in actuating control. Pump not delivering fluid for any of the above reasons. Relief valve setting not high enough. Relief valve sticking open. Leak in hydraulic control system (cylinders or valves). Free circulation of fluid to reservoir.	Clean control Check circulation by watching fluid in reservoir. Block machine travel. Test with pressure gauge. Remove contamination in relief valve. Test independently by progressively blocking off the circuit. Insure that directional valve is not in open center (neutral) position or that fluid is not discharging to tank through an open line or improperly adjusted valve.
PUMP MAKING NOISE	Partly clogged intake line, intake filter, or restricted intake pipe. Air leak at pump intake pipe joints. Air bubbles in fluid. Reservoir air vent plugged. Pump running too fast. Filter too small on intake. Coupling misalignment.	Pump must receive intake fluid freely or cavitation takes place. Tighten as required. Pour fluid on joints while listening for change in sound of operation. Check to be certain return lines are below fluid level and well separated from intake line. Must be open through breather opening or air filter. Conform with recommended maximum speeds on installation drawings. Refer to appropriate installation drawing for proper size filter. Check for damaged shaft bearing or other parts. If necessary, replace and realign the coupled shafts.
MOTOR SHAFT DOES NOT TURN. INSUFFICIENT SPEED OR POWER.	System overload relief valve set too low to permit necessary pressure. Valve plate and cylinder block surface scored by abrasive in hydraulic fluid.	Check pressure and increase relief valve setting, but not above recommended maximum. Check external leakage at drain port. Remove motor. Install new rotating group. Replace scored valveplate. Flush system with clean oil.
MOTOR TURNING IN WRONG DIRECTION	Pump or other components in system not functioning properly. Incorrect connection.	Check directional control and pump stroke position. Check circuit and connect correctly.
EXTERNAL LEAKAGE FROM MOTOR	Worn seal or gaskets. Gaskets leaking due to improperly connected reservoir drain.	Install new seal and/or gaskets. Connect drain line directly to reservoir below the fluid level.
SPEED FLUCTUATIONS WITH CONSTANT INPUT FLOW	Irregular wear between valve plate and cylinder block.	Replace damaged parts.

Table 3. Troubleshooting Pumps/Motors

7. The rotating group consists of retaining ring (12), lift limiter (13), spring (14), thrust washer (15), cylinder block (16), pins (17), backup washer (18), spherical washer (19), shoe plate (20) and piston/shoe subassembly (21). Turn the rotating group slightly to free it from the swash plate (22). Tilt housing

(36) and remove the rotating group. During removal, use care to prevent separation of the rotating group. Disassemble the rotating group as follows: (Refer to Figures 2 and 3 during disassembly.)

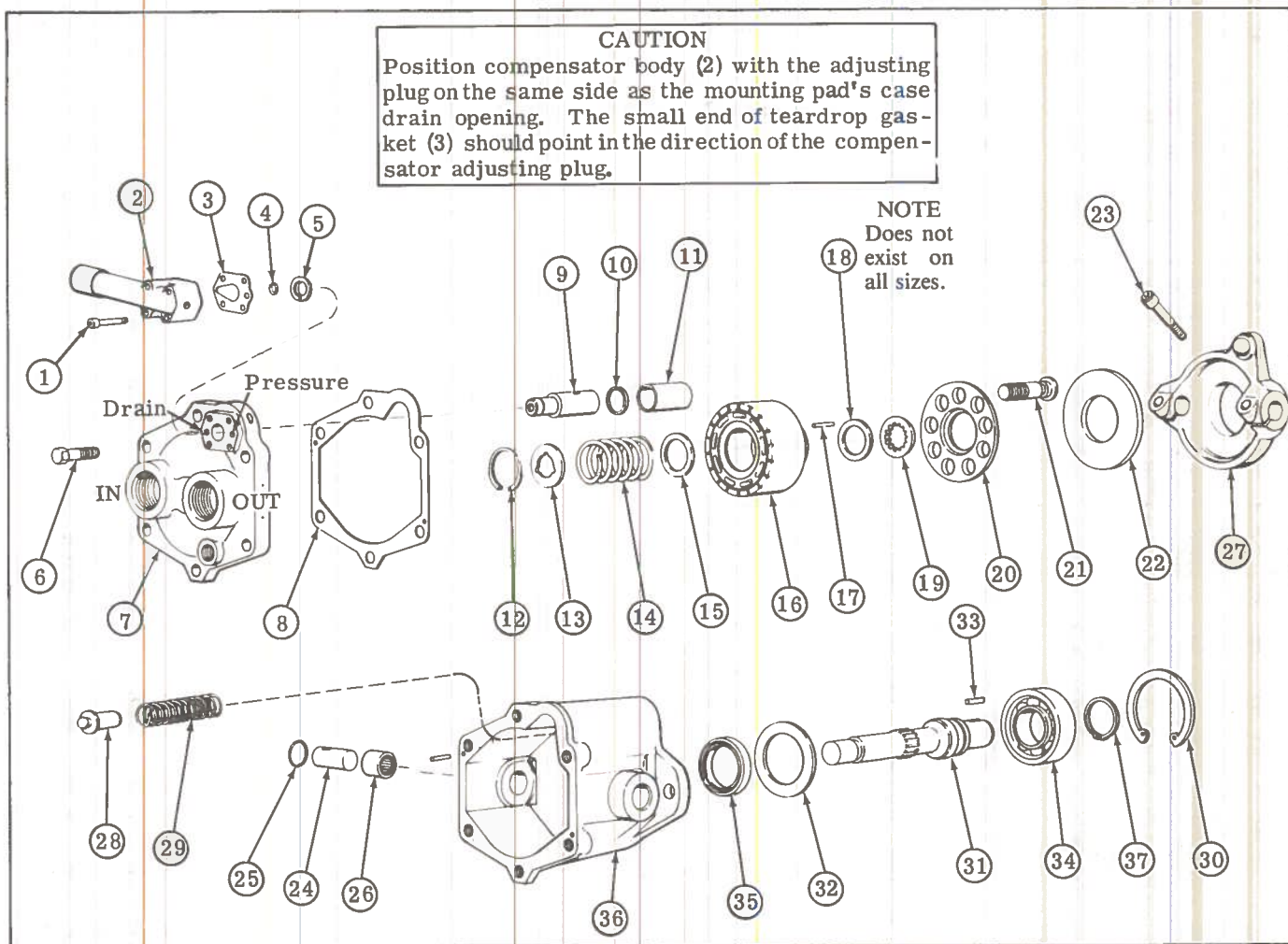


Figure 2. Exploded Parts Breakdown

ITEM	NOMENCLATURE	QTY.	ITEM	NOMENCLATURE	QTY.
1	Screw (Compensator)	4	19	Spherical Washer	1
2	Body (Compensator)	1	20	Shoe Plate	1
3	Gasket (Compensator)	1	21	Piston/Shoe Subassembly	9
4	"O" Ring (Compensator)	1	22	Swash Plate	1
5	Retaining Ring (Compensator)	1	23	Screw (Yoke)	2
6	Screw	6	24	Pintles	2
7	Valve Plate	1	25	"O" Ring (Pintle)	2
8	Gasket	1	26	Bearing (Pintle)	2
9	Piston Rod	1	27	Yoke Subassembly	1
10	Spacer	1	28	Seat	1
11	Piston	1	29	Spring	1
12	Retaining Ring	1	30	Retaining Ring	1
13	Lift Limiter Washer	1	31	Drive Shaft	1
14	Spring	1	32	Shaft Seal Retainer	1
15	Thrust Washer	1	33	Drive Shaft Key	1
16	Cylinder Block	1	34	Bearing (Drive Shaft)	1
17	Pin	3	35	Shaft Seal	1
18	Backup Washer	1	36	Housing	1
			37	Retaining Ring (Bearing)	1

Figure 2. Part Nomenclature

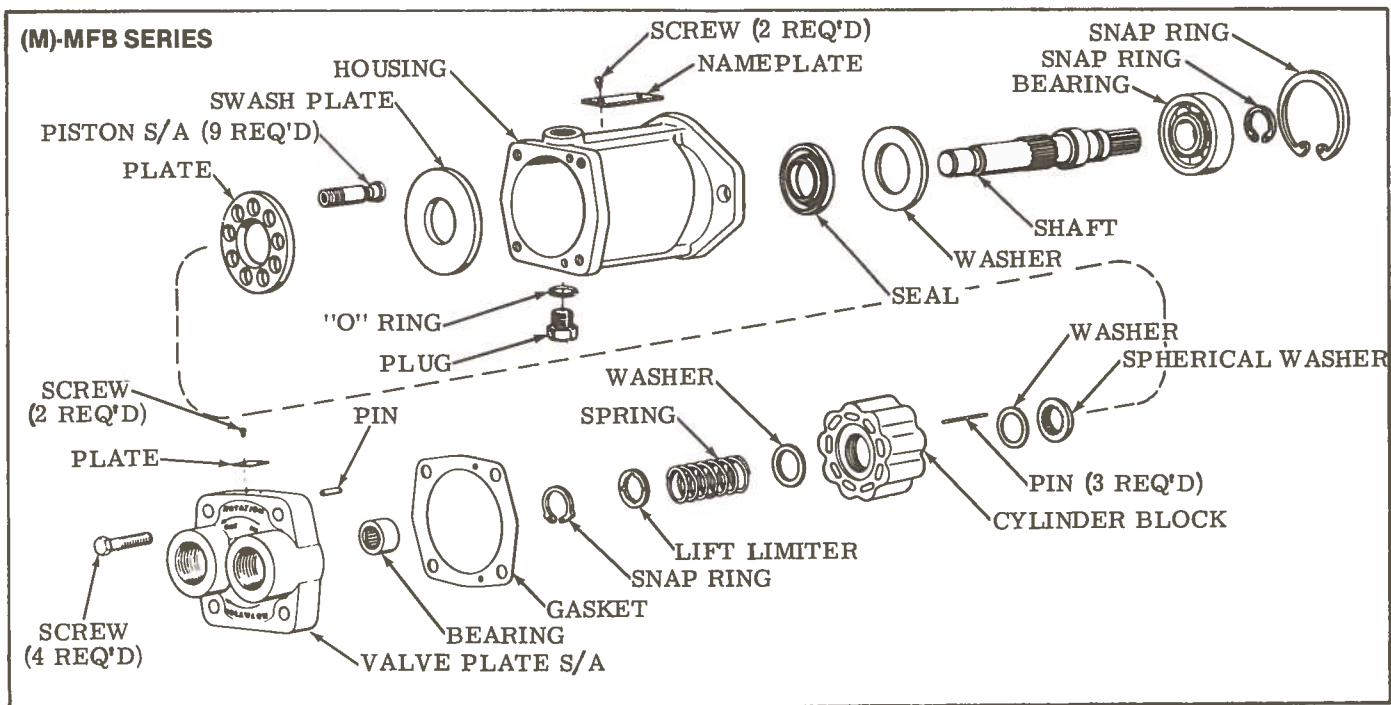


Figure 2a. Typical Fixed Displacement Motor

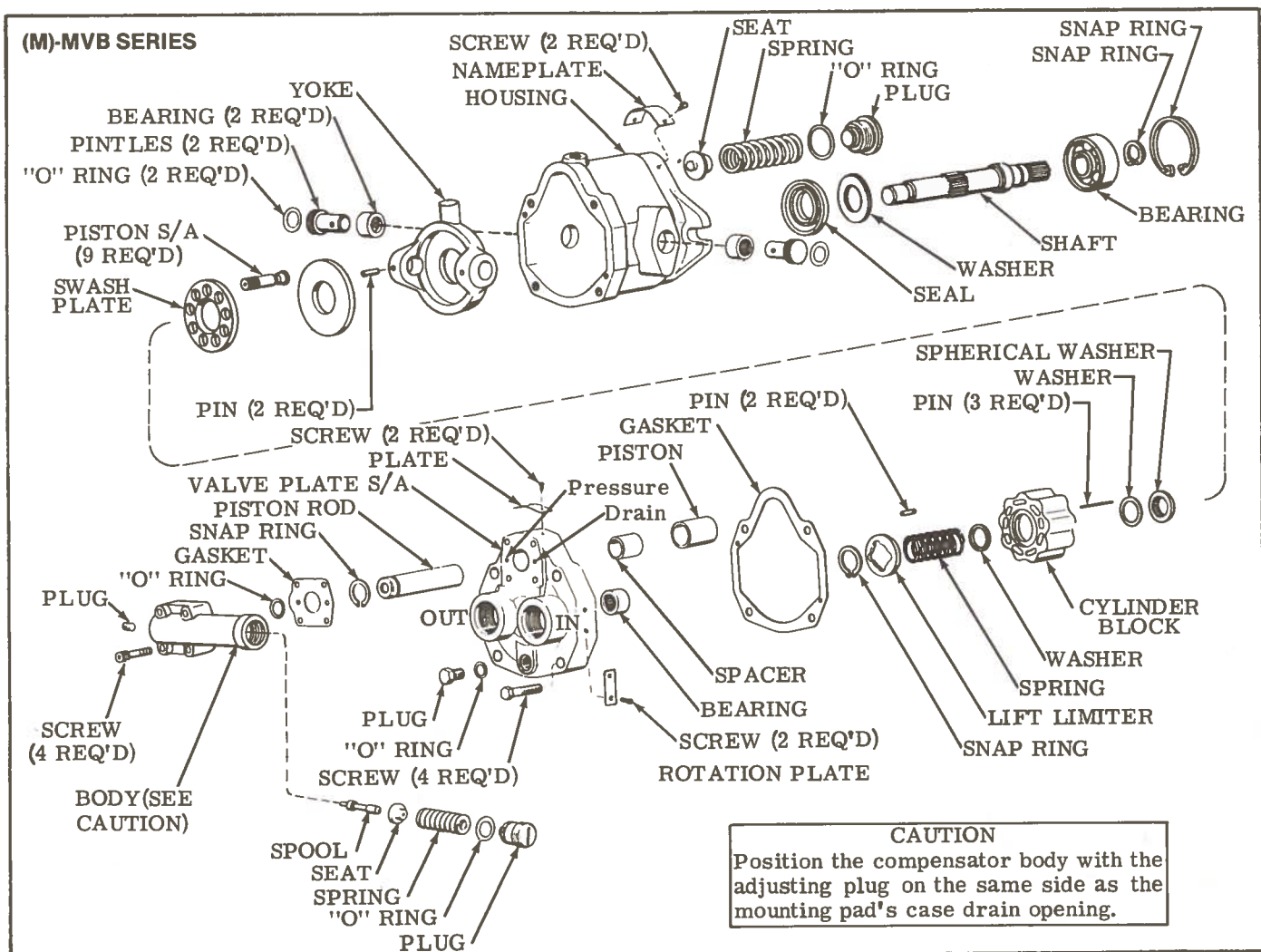


Figure 2b. Typical Variable Displacement Motor

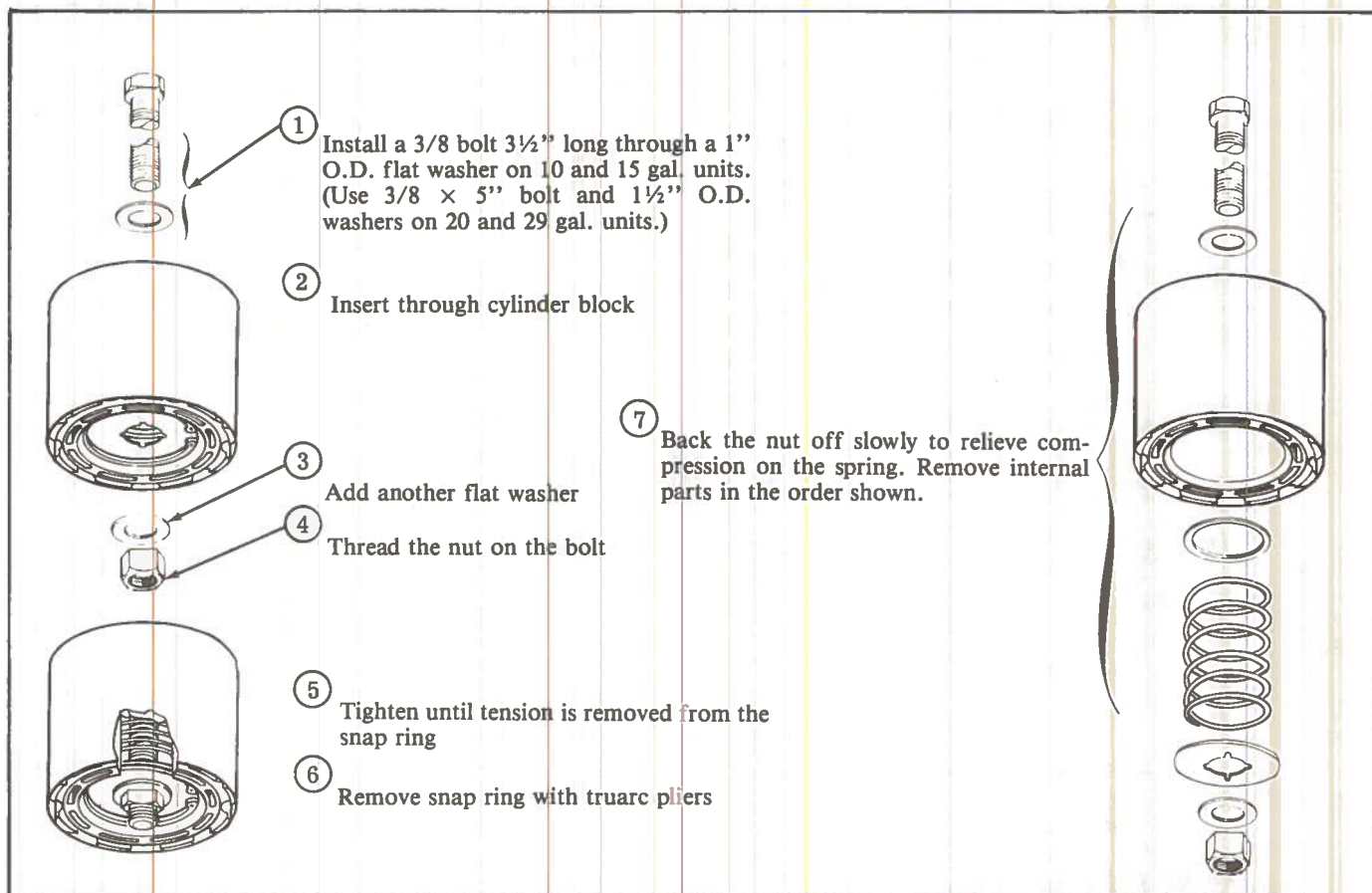


Figure 3. Cylinder Block Disassembly

a. Place the rotating group face down on a clean piece of Kraft paper.

b. Grasp shoe plate (20) and lift nine piston and shoe subassemblies (21) from cylinder block (16) with the shoe plate. Be careful not to strike the pistons together hard enough to create a burr or damage the pistons.

c. Remove spherical washer (19), backup washer (18) and pins (17). (Note: Some units do not use a backup washer.)

d. Observe caution during removal of spring (14) located within the cylinder block. The spring is under high compression and can cause bodily harm if retaining ring (12) is removed without adequate tooling. See Figure 3 for removal procedure.

8. Remove retaining ring (30) from housing (36) with truarc pliers.

9. Remove drive shaft (31), bearing (34), key (33), and retaining ring (37) from mounting flange of housing (36). Set aside for inspection.

10. Remove swash plate (22) from yoke subassembly (27). Rotate swash plate (22) and pull evenly from the yoke. Set aside for inspection.

11. Remove two screws (23) from yoke (27).

12. Remove pintles (24) with "O" rings (25) from yoke (27). Refer to Figures 4 and 5.

13. Remove yoke (27), refer to Figures 4 and 5, the yoke removal procedure for a variable displacement pump or motor.

14. Variable displacement units require removal of seat (28) and spring (29) from within housing (36).

15. Remove washer (32) and shaft seal (35) from the housing. Be careful during the removal of the shaft seal. DO NOT scratch the housing to seal mounting surface. Leakage can occur between the seal and housing if the aluminum housing is scratched.

C. INSPECTION, REPAIR AND REPLACEMENT

Prior to inspection, clean all parts thoroughly with a solvent that is compatible with system fluid. Replace all parts that do not meet the following specifications.

1. Valve Plate (7) - Lapping of the valve plate is not recommended. If wear or scoring is apparent, replace the valve plate. Check the shaft bearing located within the valve plate for roughness and pitting of the rollers. Replace if defective. Remove paint and/or burrs from outer edge of valve plate with an India stone.

2. Piston Rod (9), Spacer (10) and Piston (11) - Inspect compensator piston rod and piston for fit and/or wear. Spacer (10) is used on some models to limit maximum flow. Replace if defective.

3. Rotating Group Parts

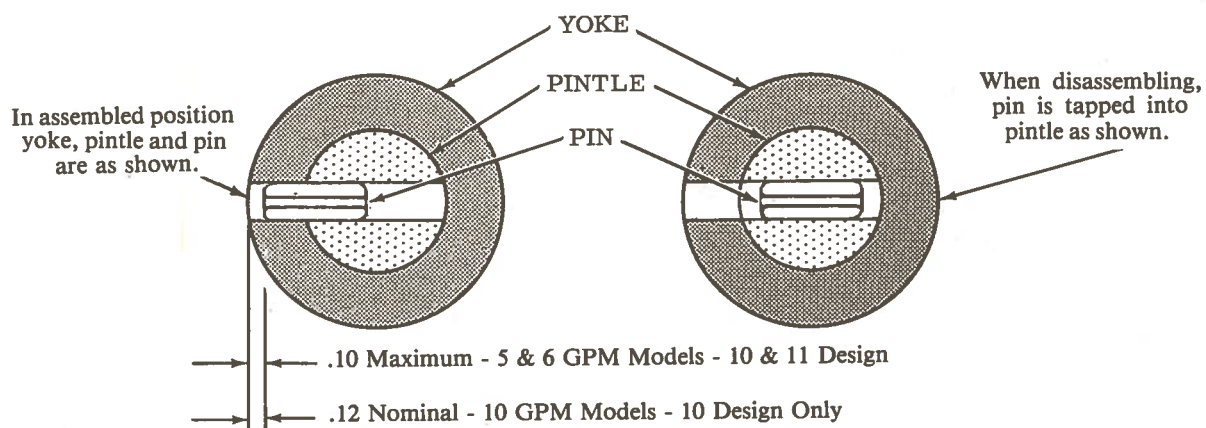
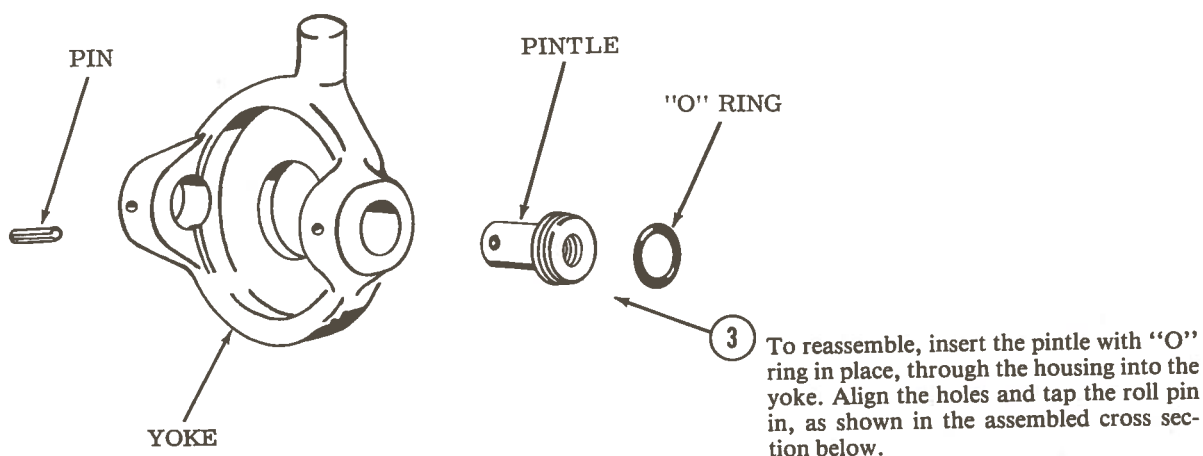
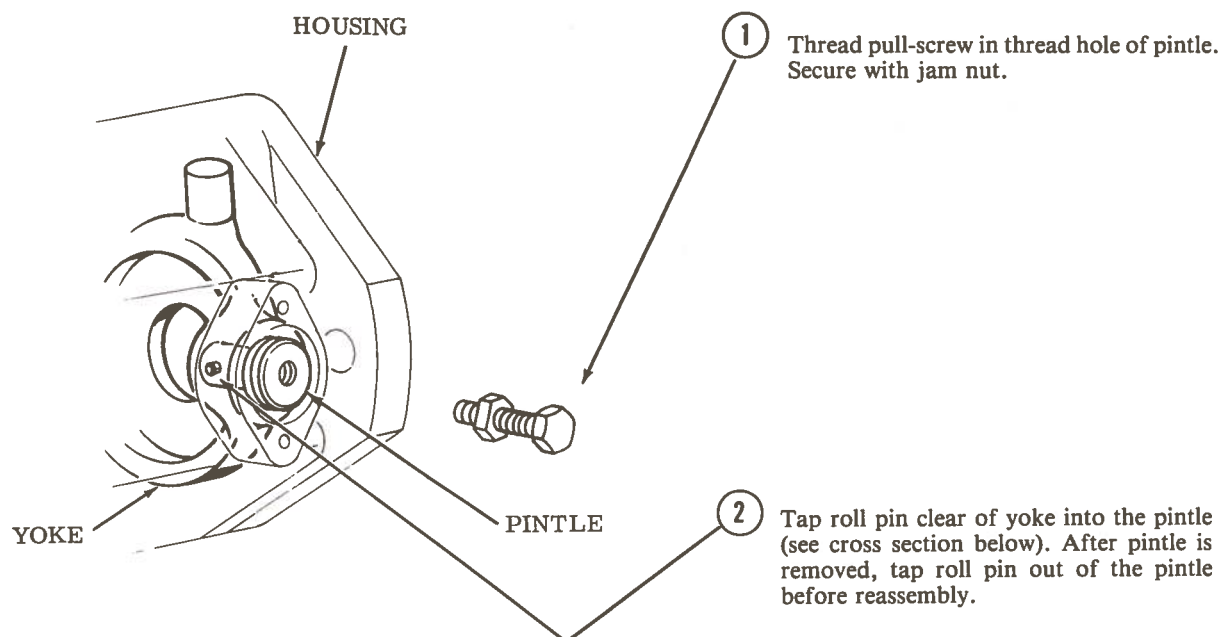
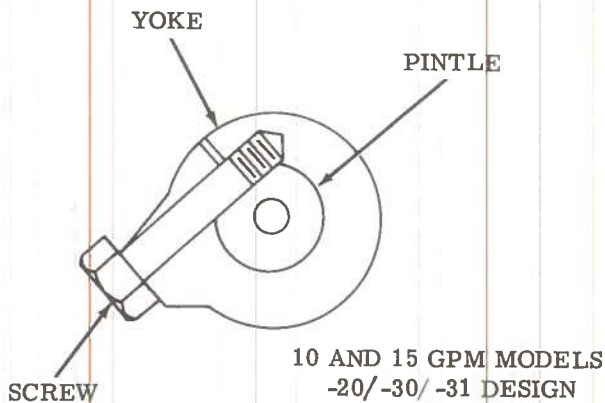
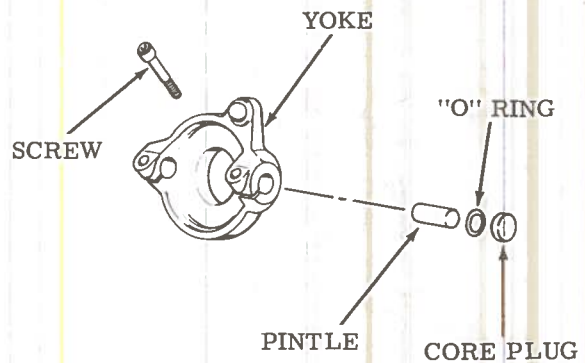


Figure 4. Removal of Pintle and Yoke, Smaller Models

The 10 and 15 GPM units of the -20/30/31 designs use a screw in lieu of the roll pin for securing pintles. The pintles are provided with a groove in place of the drilled hole to accept the screw (see cross section below).



- (1) Remove the core plug. Back-off lock screw at yoke until pindle groove clears for 20 and 29 GPM models. Lightly tap pindle toward inside of unit to remove. NOTE: Swash plate must be removed from yoke to remove these pintles.



- (2) To reassemble, insert the pindle through the housing into the yoke. Align the grooves and thread in lock screw.

Figure 5. Removal of Pindle and Yoke, Larger Models

a . Inspect shoe plate (20) for wear or cracking in the area of spherical washer (19). If wear or cracks are found, replace the shoe plate and spherical washer at the same time.

b . Check spherical washer (19) for burrs and wear. Replace if defective.

c . Inspect pins (17) for equal length, wear and possible bending. Replace all pins simultaneously if one is defective.

d . Backup washer (18) does not exist in all models. Check for wear and replace if necessary.

e . Check each cylinder block (16) bore for excessive wear. Use the piston/shoe subassemblies (21) for this purpose. The piston should be a very close fit and slide easily in and out of the bore. No bind can be tolerated. If binding occurs, clean the cylinder block and piston, lubricate with clean hydraulic fluid and try again. Even minor contamination of the fluid can cause the piston to freeze up in the cylinder block bore.

f . Inspect each piston and shoe subassembly (21) for a maximum end play of 0.003 inch between the piston and shoe. The face thickness dimension, as shown in Figure 6, of each shoe must be within 0.001 inch of each other. A variation greater than 0.001 inch between all nine shoes indicates excessive wear. If one shoe needs replacement, replace all piston/shoe subassemblies. Replacement as a matter of procedure is recommended to obtain maximum overhaul life of the unit.

g . Inspect retaining ring (12), lift limiter washer (13), spring (14) and thrust washer (15) within cylinder block (16) for wear. Replace if necessary.

4. Inspect the face of swash plate (22) for wear, scratches and possible fracture. If the swash plate needs replacement, make sure the new swash plate rests flat against the face of yoke subassembly (27).

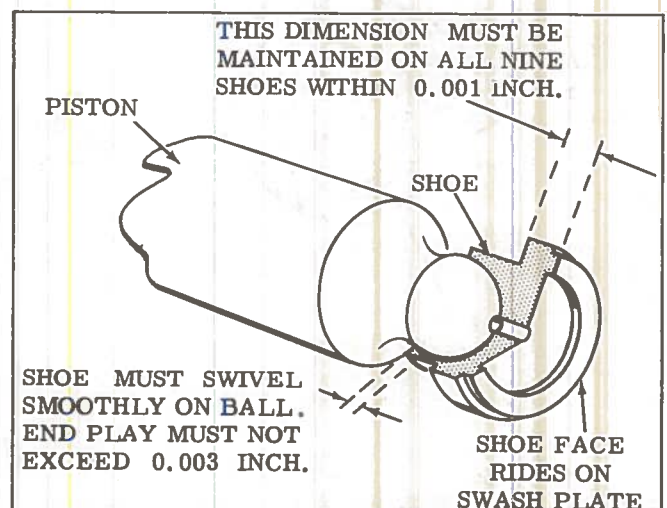


Figure 6. Piston and Shoe Assembly Tolerances

5. Inspect drive shaft (31) for wear, a chipped spline and burrs. Remove burrs with an India stone. Inspect the contact area of the shaft seal for wear and/or scoring. Replace the drive shaft if wear or scoring is greater than 0.005 T.I.R. (total indicator reading).

6. Inspect drive shaft bearing (34) for roughness in turning, pitting of the rollers and excessive end play. Replace if defective. If the bearing or shaft require replacement, removal of the bearing from the shaft is required. Use appropriate tooling to hold the inner race of the bearing and press the shaft from the bearing. Assemble new parts together in a similar manner, always applying force to the shaft and inner race of the bearing. DO NOT apply force to the outside bearing race. Install retaining ring (37).

7. Inspect yoke subassembly (27) face for wear, roughness or scoring. Check pintle bores of yoke for wear. Replace if defective.

8. Inspect pintles (24) and pintle bearings (26) for wear. Replace if defective. If a pintle bearing requires replacement, use a tool smaller than the housing bore and drive the pintle bearing into the housing and remove. Be careful not to score the housing bore during removal. Clean up the bore and lubricate both the bore and new pintle bearing with system fluid. Be very cautious during installation of new pintle bearings. If a bearing is misaligned with the bore at start of press, the bearing cage will warp and a bind will occur. Use an arbor press to install new pintle bearings. DO NOT press a bearing past the inside lip of the housing or interference with the yoke will result.

9. Inspect housing (36) mounting flange for nicks and burrs. Remove with an India stone. Remove paint and/or burrs from outer edge of housing.

D. ASSEMBLY

Assembly is performed in the reverse order of disassembly. Special procedures are noted in the following text.

A new seal kit should be obtained. Refer to the parts drawing for your model (see Table 1). Replace all seals, gaskets and "O" rings with new ones from the kit. A light film of clean hydraulic fluid will provide ease of assembly and initial lubrication of moving parts. Assemble as follows:

1. Install new shaft seal (35) into housing (36) with spring loaded member facing into the housing.

2. Install spring (29) over spring guide in housing. Insert seat (28) into spring.

3. Install yoke (27) in housing (36) as illustrated in Figures 4 and 5. Make sure seat (28) is in position and engages within the yoke.

4. Install pintles (24) and "O" rings (25) as illustrated in Figures 4 and 5. Install screws (23) and torque to recommended values. Refer to parts drawing for applicable unit found in Table 1.

5. Place shaft seal retainer (32) over shaft seal. Install drive shaft (31) and retaining ring (30) up against bearing into housing groove.

6. Lubricate and install swash plate (22) with chamfer side facing yoke (27). It is important that the swash plate be properly seated within the yoke and can be freely moved (rotated) with the fingers.

7. If the cylinder block was disassembled, refer to Figure 3 for assembly. Place the cylinder block face down on a clean piece of Kraft paper and insert three pins (17) into the cylinder block. Lubricate back-up washer (18) (not used on some models) and spherical washer (19), place them over pins (17). Lubricate the cylinder block bores and pistons with system fluid. Install the nine pistons (21) through shoe plate (20) and into the cylinder block bores. The pistons must move freely within the bores. The rotating group is now assembled and ready for installation into the pump or motor housing. Hold cylinder block (16) and shoe plate (20) together to keep pins (17) and washer(s) (18 & 19) intact, then install rotating group over the drive shaft. A slight rotation of the drive shaft during assembly will help align spherical washer (19) and cylinder block (16) splines with those of the shaft.

8. Lubricate the face of the valve plate. Make sure paint and burrs have been removed from the outer edge of housing (36) and valve plate (7). Install gasket (8) on housing (36).

9. Install piston rod (9) into valve plate. Slide retaining ring (5) over piston rod (9) and into retaining ring groove. Install spacer (10) (used only on models with reduced flow capability), and piston (11) over piston rod (9).

10. Align drive shaft to bearing and install valve plate (7) on housing (36). Thread retaining screws (6) through valve plate and into housing. Torque to the values noted in parts drawing for the unit.

11. Lubricate and install "O" ring (4) in "O" ring groove of piston rod (9). Install gasket (3) on valve plate (7). CAUTION: Position gasket as shown in Figure 2 with teardrop hole pointing toward compensator adjusting screw.

12. Place compensator body (2) over gasket (3) on valve plate (7). Make sure body of compensator and gasket are installed in the correct position for shaft rotation (see Figure 2). Thread retaining screws (1) through compensator into valve plate. Torque screws to the values noted on parts drawings for the unit.

13. Install drive shaft key (33) into drive shaft (31). Make sure key is seated properly.

E. CONVERSIONS

When changing the direction of rotation of an inline hydraulic pump, it will become necessary to change to the respective valve plate for that rotation. If the pump happens to be a compensated type, the compensator must be rotated 180° and the compensator gasket must follow. Consult the appropriate parts drawing listed in Table 1 for the proper valve plate selection.

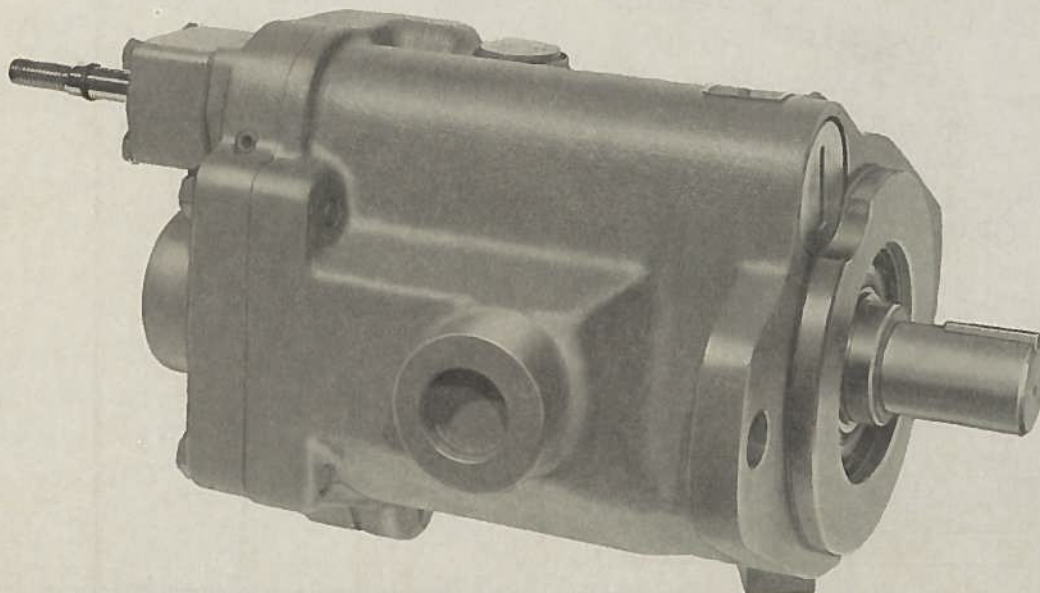
Hydraulic motors with "V" in the model code require only the rotation of the compensator to change direction. When a change such as this is made, it should be noted by a change in the name plate and any directional arrows as an aid in future identification.

Service Parts Information

**20 & 29 GPM
Variable
Inline
Piston
Pumps**

PVB20-(F)*S-10-D-10
PVB29-(F)*S-10-D-10

17

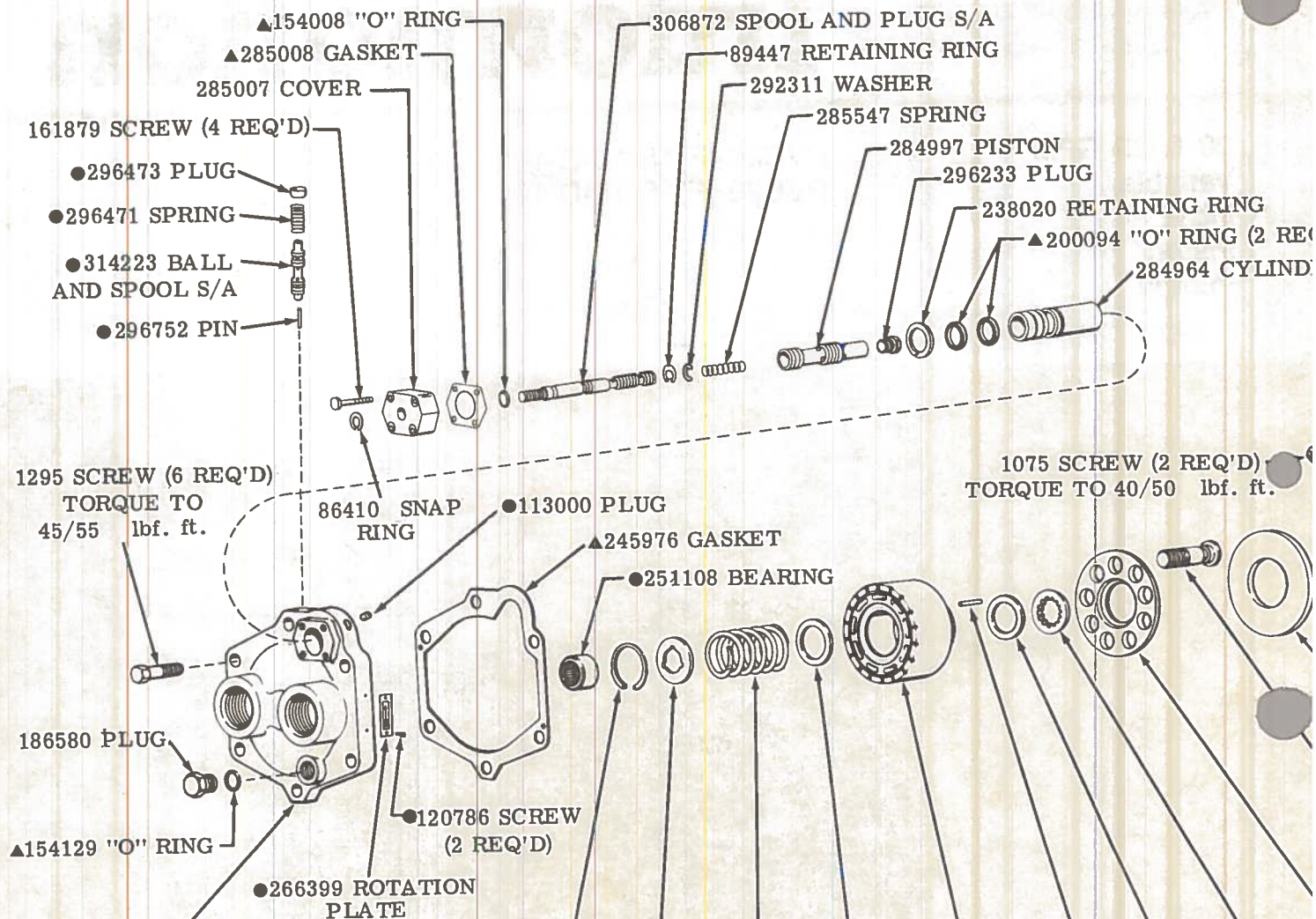


Vickers, Incorporated

P.O. Box 302
Troy, Michigan 48007-0302

Revised 12-1-87

I-3275-S



VALVE PLATE SUBASSEMBLY	MODEL
938399	PVB20-(F)RS-10-D-10
938408	PVB29-(F)LS-10-D-10
938409	PVB29-(F)RS-10-D-10

MODEL	RETAINING RING	WASHER	SPRING	WASHER	CYLINDER BLOCK	PIN (3 REQ'D)	WASHER V		
	THESE PARTS INCLUDED IN								
PVB20-(F)LS-10-D-10	194025	244931	246386	238780	250688	248835	238836		
PVB20-(F)RS-10-D-10			263582		259458				
PVB29-(F)LS-10-D-10									
PVB29-(F)RS-10-D-10									

● INCLUDED IN VALVE PLATE S/A

▲ INCLUDED IN 919404 SEAL KIT

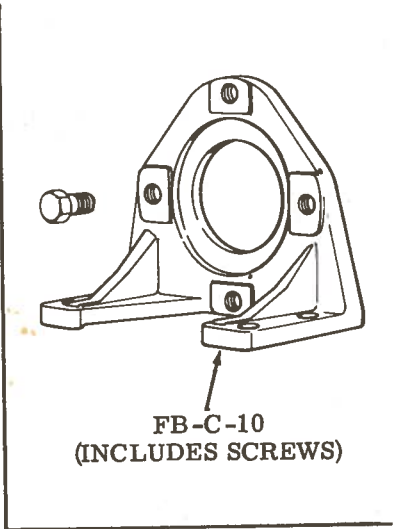
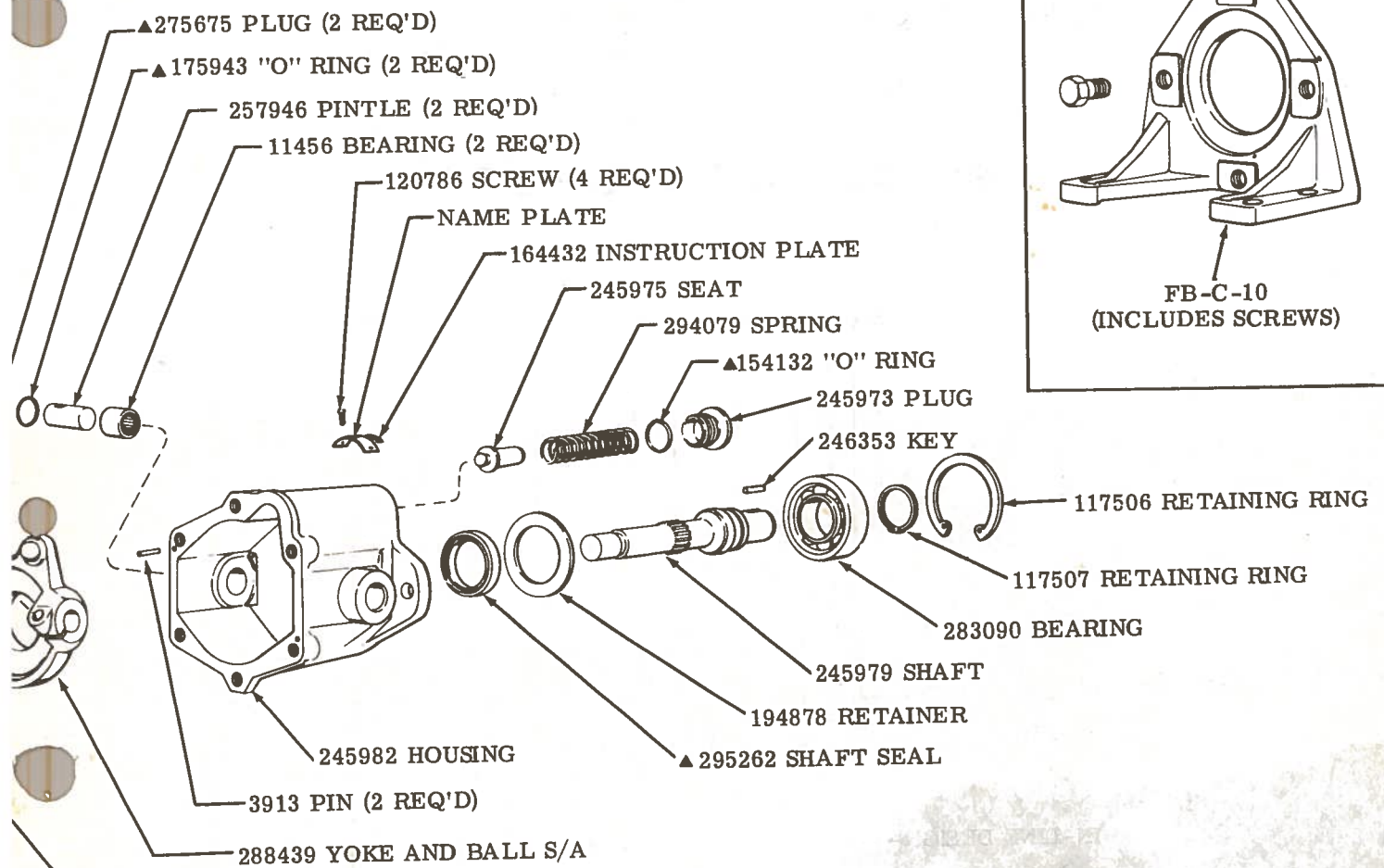
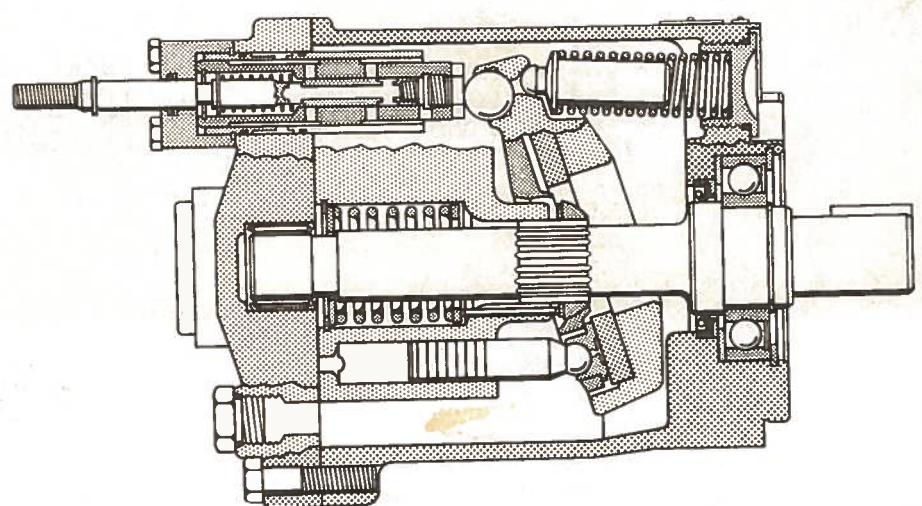
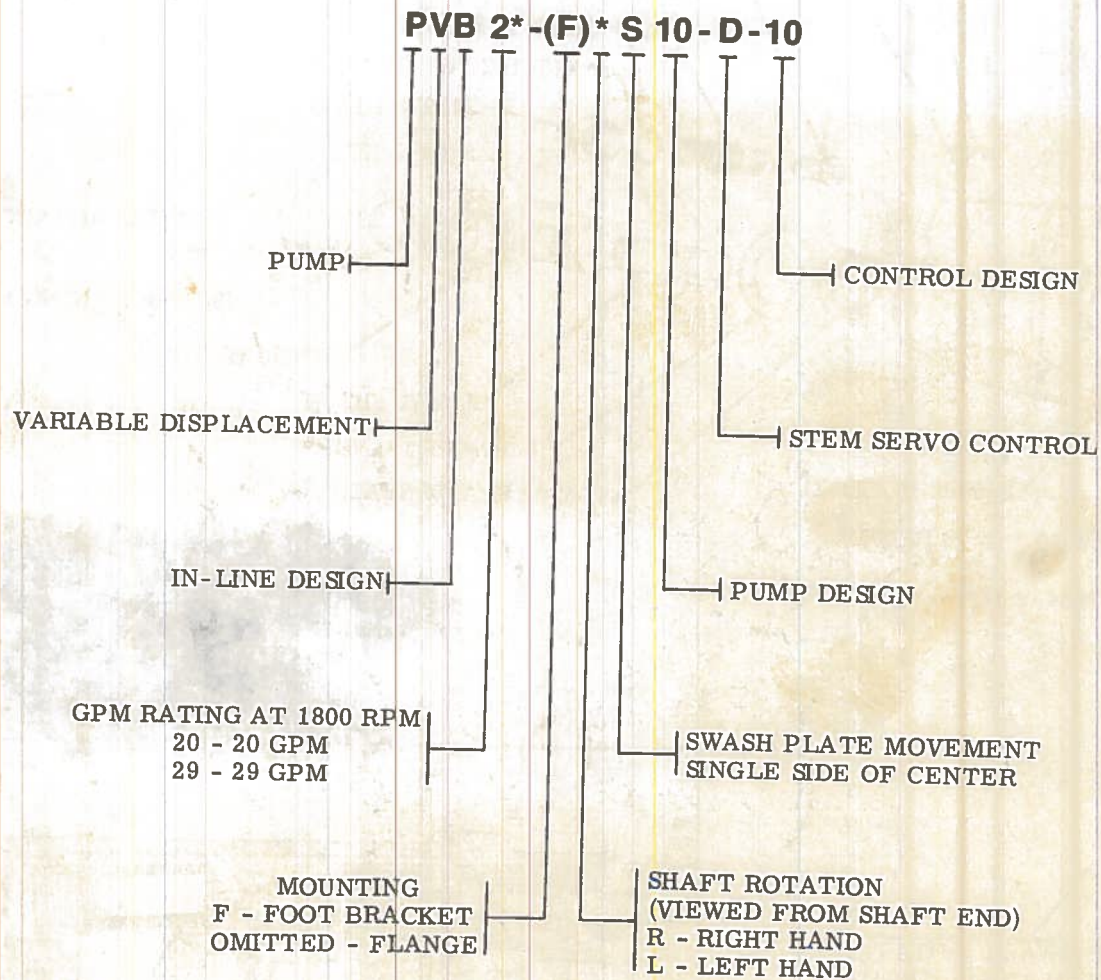


PLATE	PISTON & SHOE KIT	SWASH PLATE	ROTATING GROUP
248609	941883	239335	938280
	941888		938290



MODEL CODE BREAKDOWN



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

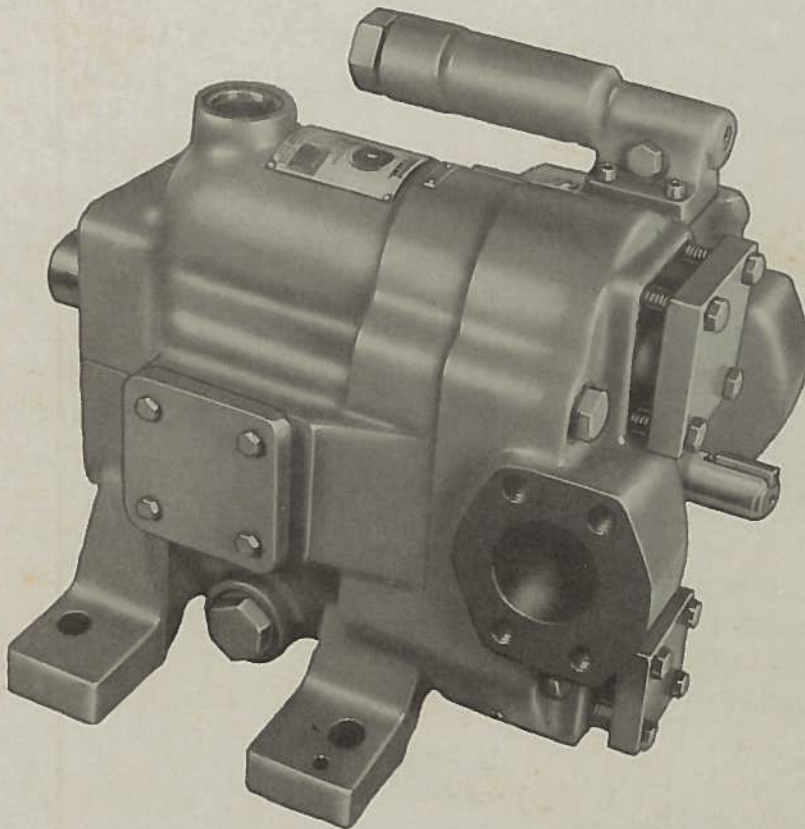
VICKERS®
A TRINITY COMPANY

Service Parts Information

**45 GPM
Variable
Delivery
Inline Piston
Pumps**

PVB45-(F)*SFW-20-C(*) (*)-11(S67)
PVB45-(F)*SFX-20-C(*) (*)-11-(S67)

14



Vickers, Incorporated

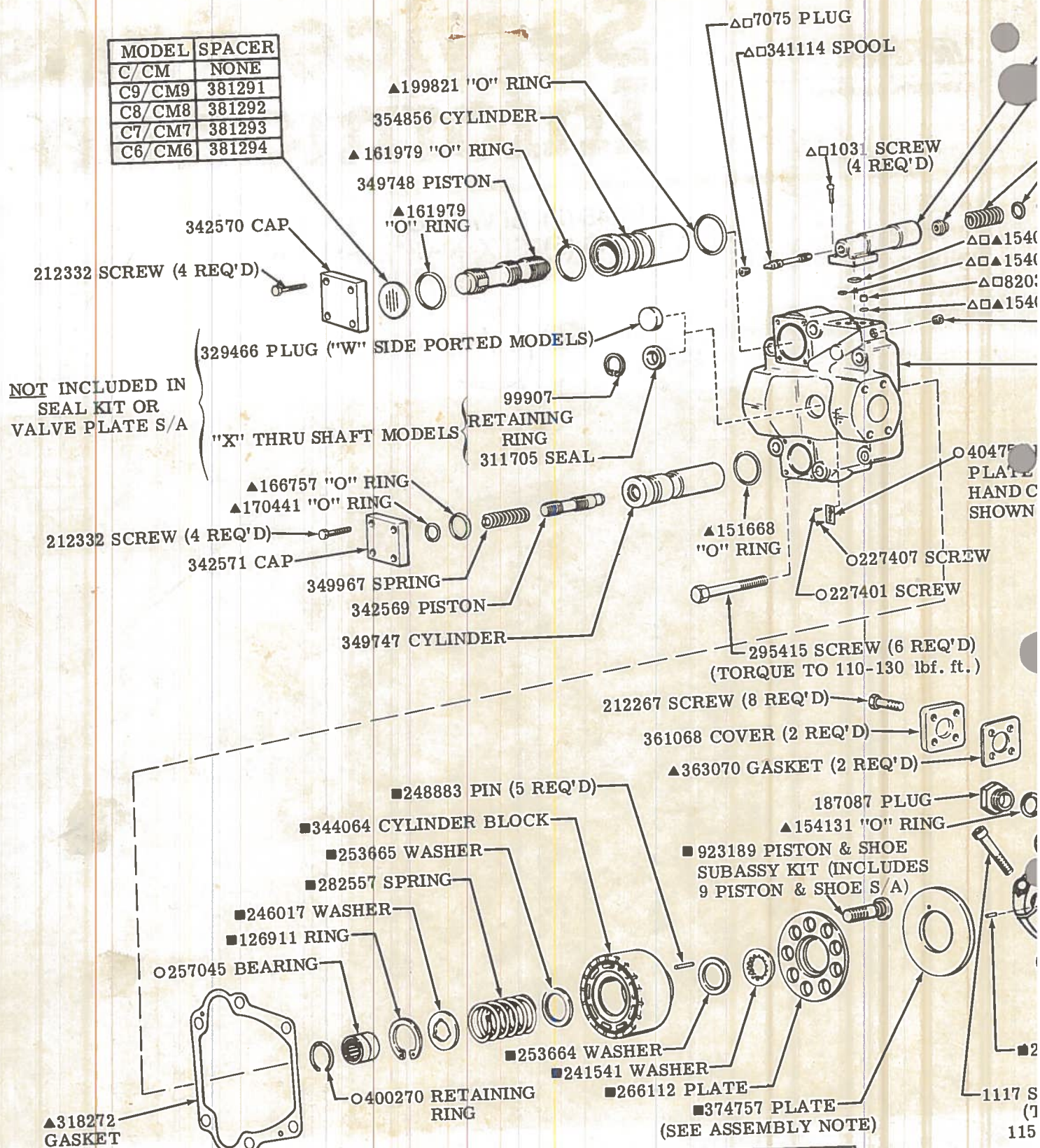
1401 Crooks Road
Troy, Michigan 48064

Revised 9-1-85

I-3297-S

104

MODEL	SPACER
C/CM	NONE
C9/CM9	381291
C8/CM8	381292
C7/CM7	381293
C6/CM6	381294



NOT INCLUDED IN
SEAL KIT OR
VALVE PLATE S/A

212332 SCREW (4 REQ'D)

349747 CYLINDER

295415 SCREW (6 REQ'D)
(TORQUE TO 110-130 lbf. ft.)

212267 SCREW (8 REQ'D)

361068 COVER (2 REQ'D)

363070 GASKET (2 REQ'D)

187087 PLUG

154131 "O" RING

923189 PISTON & SHOE
SUBASSY KIT (INCLUDES
9 PISTON & SHOE S/A)

248883 PIN (5 REQ'D)

344064 CYLINDER BLOCK

253665 WASHER

282557 SPRING

246017 WASHER

126911 RING

257045 BEARING

253664 WASHER

241541 WASHER

266112 PLATE

374757 PLATE
(SEE ASSEMBLY NOTE)

318272
GASKET

*(S-67 OPTION):
INTERCHANGEABILITY WITH THE -10 & -11 DESIGN-
FOOT MOUNTED PUMPS IS PROVIDED WITH ADAPTER
PLATE 352148 AND FOUR (4) 212468 SCREWS. MODELS
ORDERED WITH S-67 SUFFIX WILL HAVE THE ADAPT-
ER PLATE ATTACHED.

□ INCLUDED IN 942112
"C" COMPENSATOR S/A

△ INCLUDED IN 942133
"CM" COMPENSATOR S/A

■ INCLUDE
938279 ROTATING

1247355 BODY
 1247354 SEAT

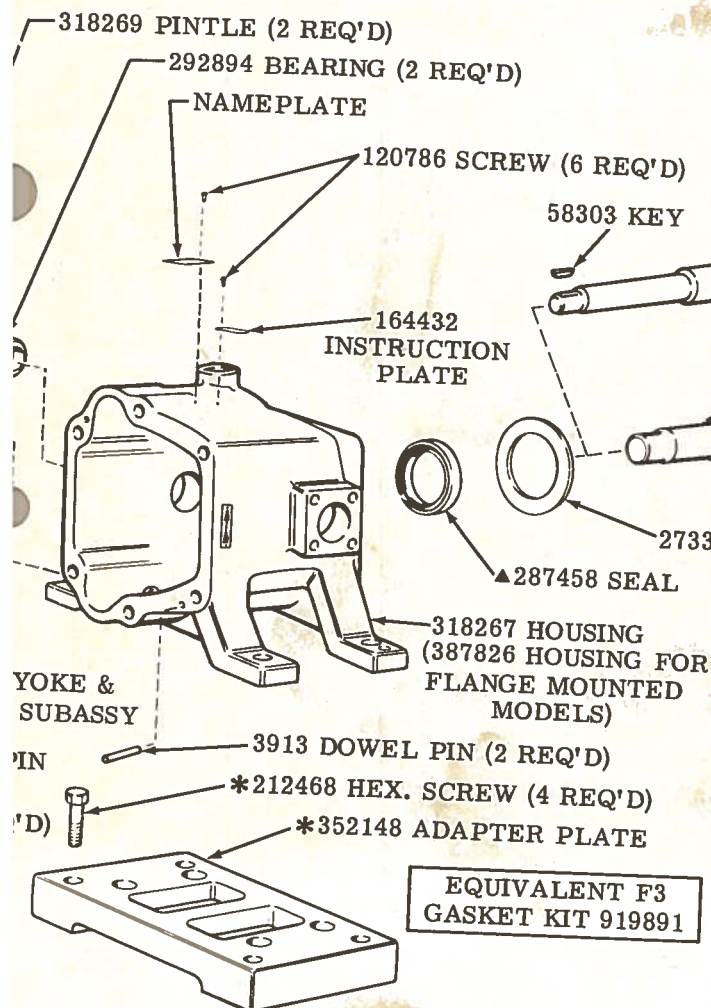
145087 SPRING (C MODELS)
 185870 SPRING (CM MODELS)
 87000 "O" RING

—△□297950 PLUG

' RING
 ' RING
 G (●SEE NOTE)
 RING
 74 PLUG (2 REQ'D) (3 REQ'D FOR L. H. MODELS)

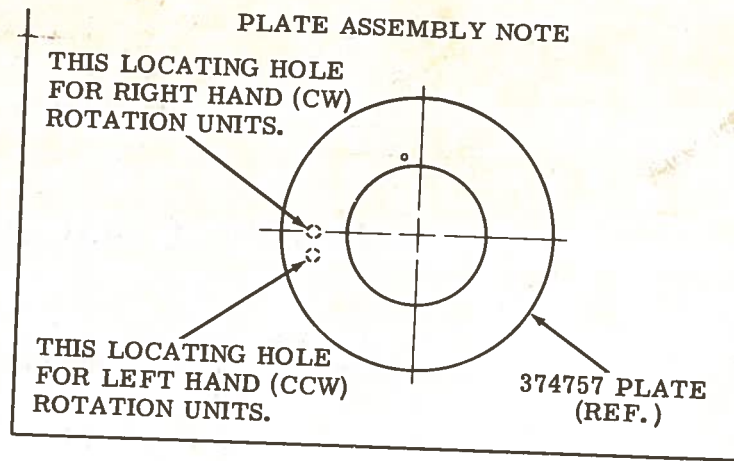
VALVE PLATE S/A	MODEL
942304	PVB45-(F)RSF*-20-C*-11
942305	PVB45-(F)LSF*-20-C*-11

TION



EQUIVALENT F3
 GASKET KIT 919891

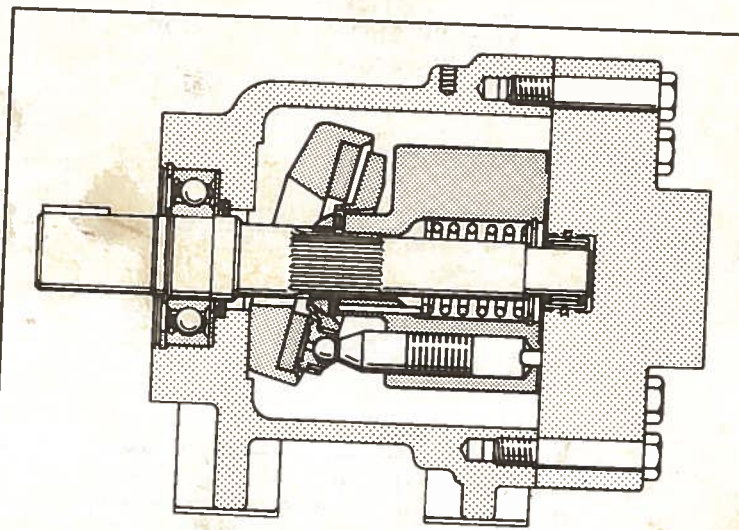
▲ INCLUDED IN
 919890 SEAL KIT



●82031 ORIFICE PLUG (MUST BE INSTALLED IN THE DRAIN PORT OF THE COMPENSATOR BODY, BELOW THE MOUNTING SURFACE.)

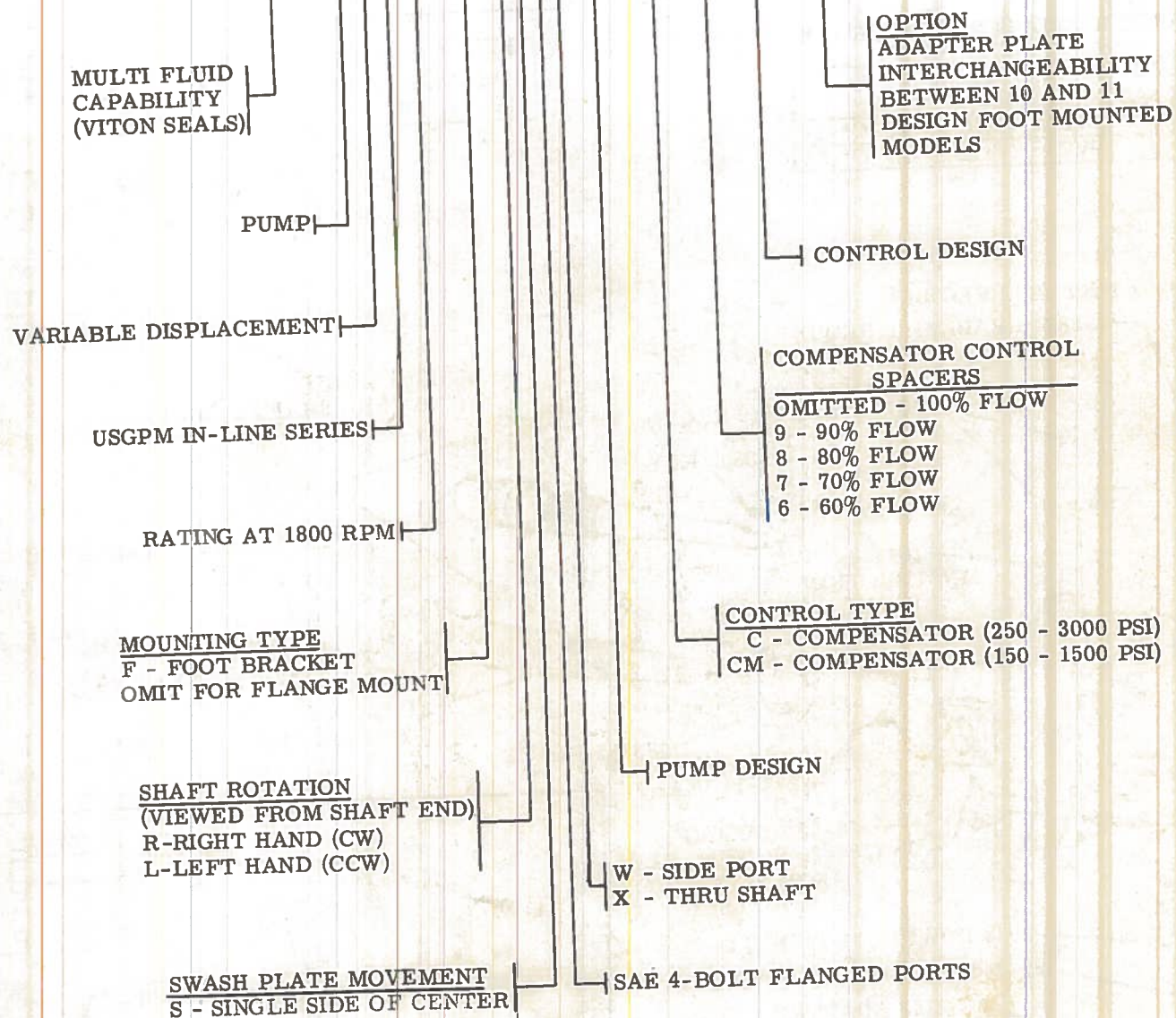
SEE PARTS DRAWING I-3963-S FOR PORT FLANGE DATA

○INCLUDED IN VALVE PLATE S/A



MODEL CODE BREAKDOWN

(F3) - PVB45-(F) *SF*-20-C(*)-11-(S67)



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

VICKERS®

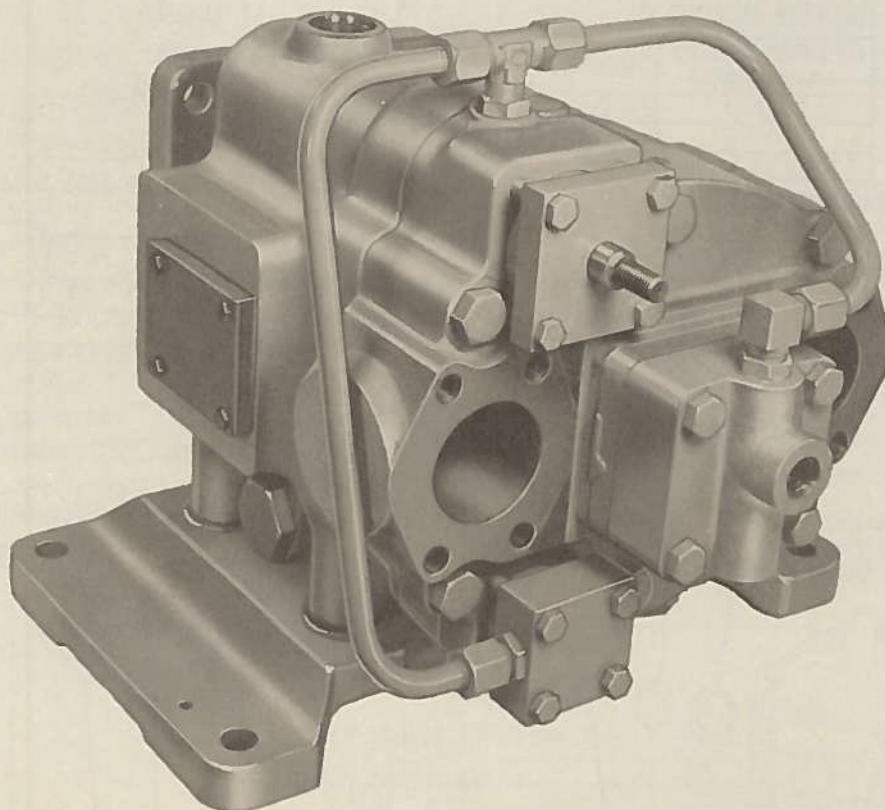
A TRIMMOVA COMPANY

Service Parts Information

90 GPM
Variable
Delivery
Inline
Piston
Pumps

PVB90-(F)*DF-2*-D(A)-1* *α*

15



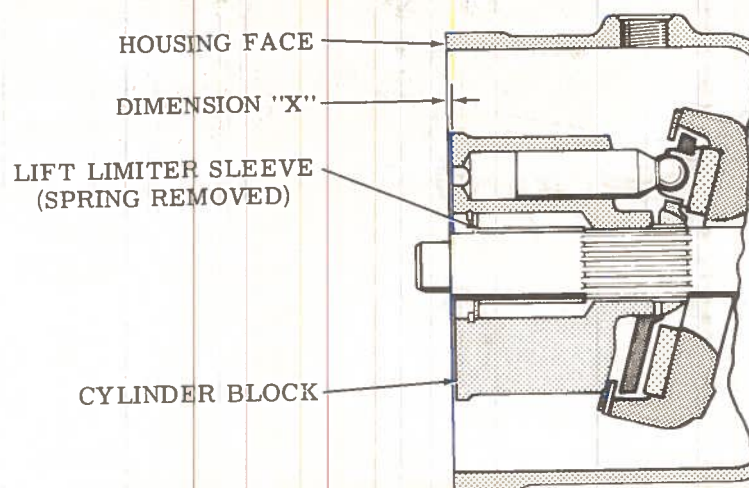
Vickers, Incorporated

P.O. Box 302
Troy, Michigan 48007-0302

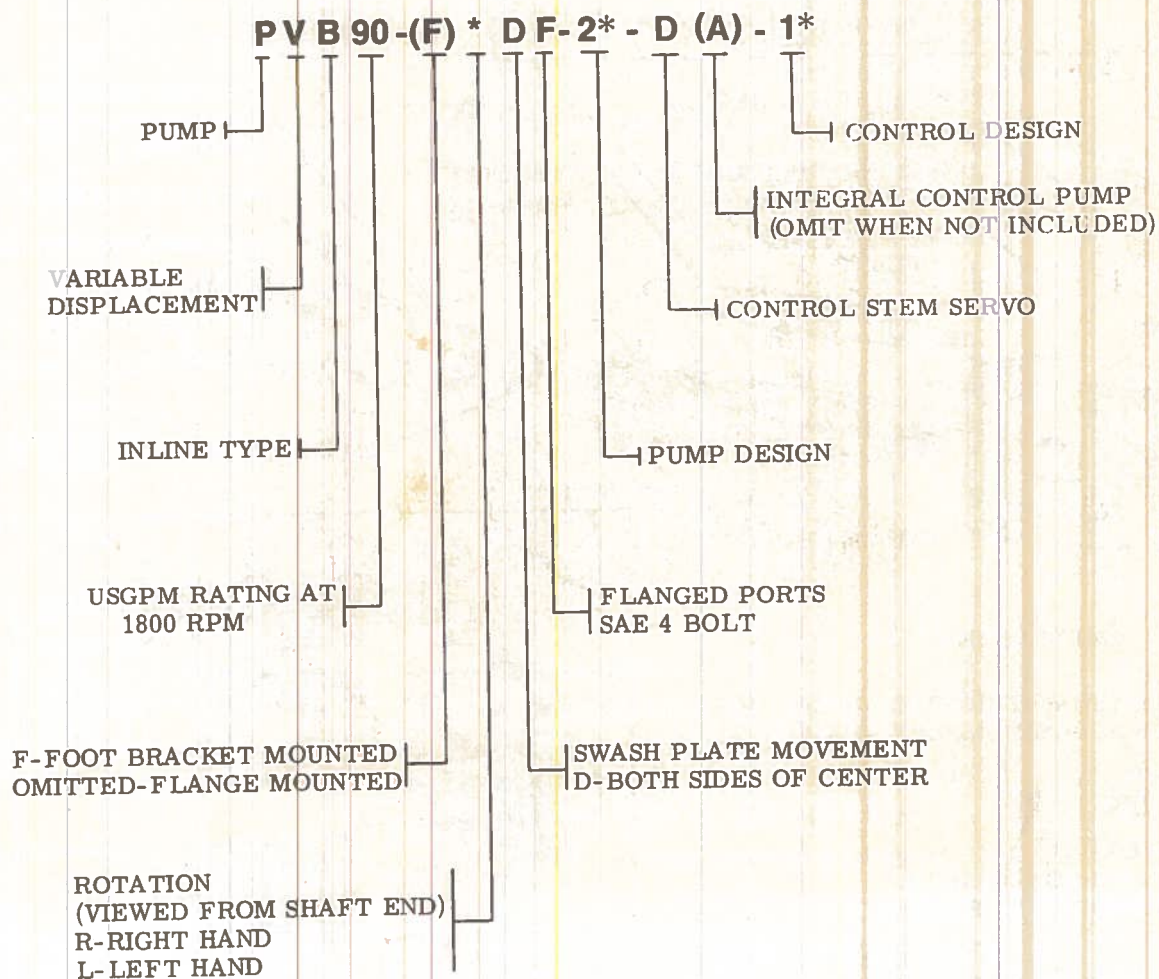
Revised 10-1-85

I-3289-S

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MODEL CODE BREAKDOWN



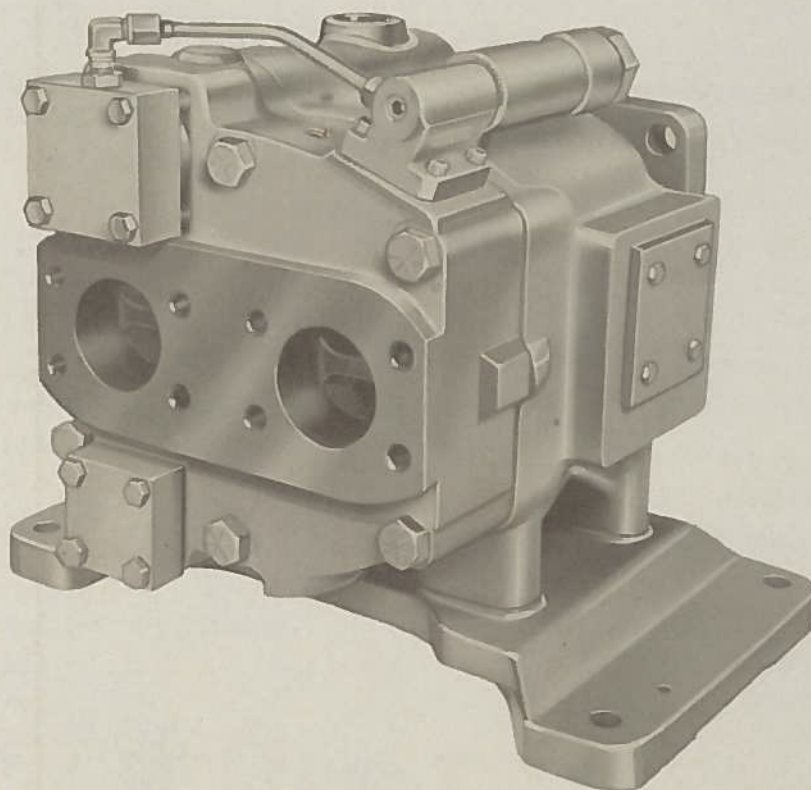
For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Service Parts Information

90 GPM
Variable
Delivery
Inline
Piston
Pumps

PVB90-(F)RSF-20-C-10
PVB90-(F)LSF-20-C-10

16



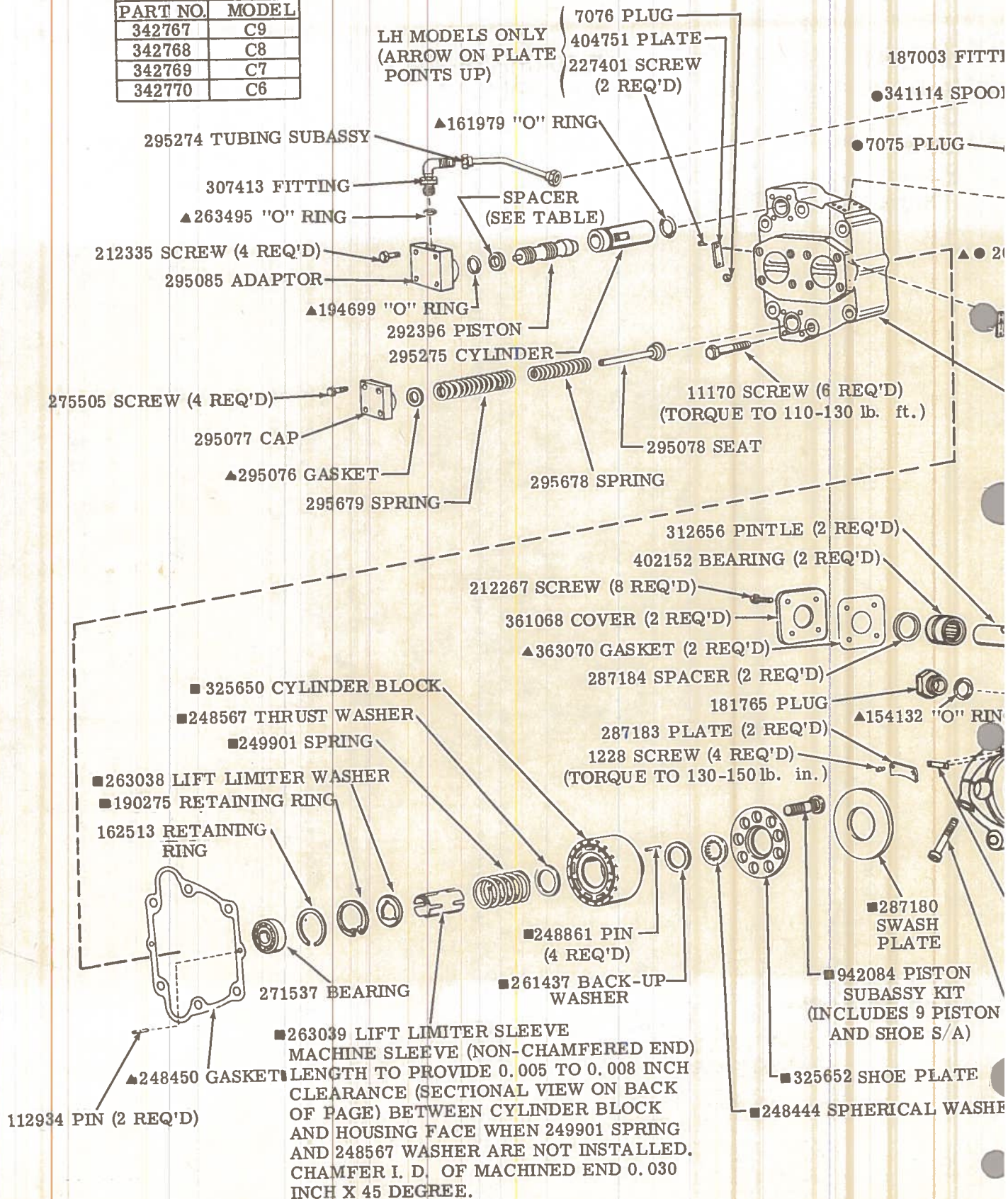
Vickers, Incorporated

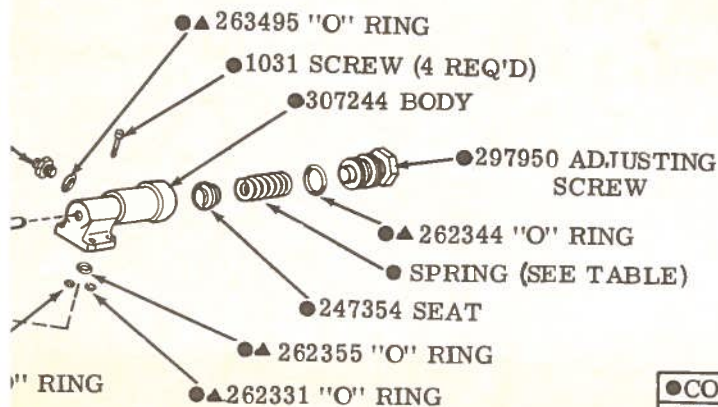
P.O. Box 302
Troy, Michigan 48007-0302

Revised 10-1-85

I-3290-S

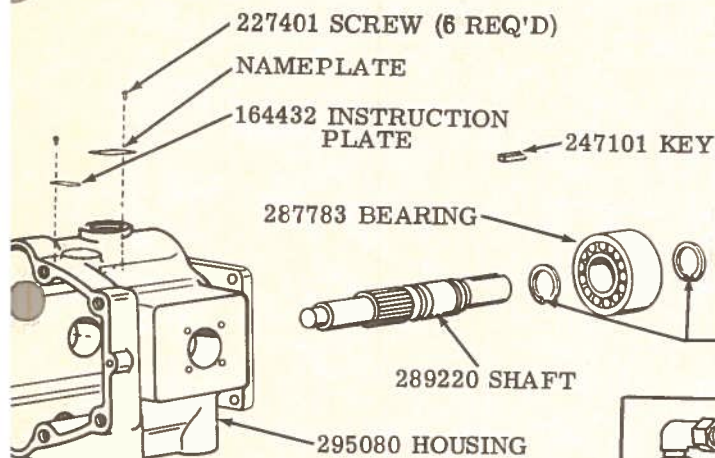
SPACER TABLE	
PART NO.	MODEL
342767	C9
342768	C8
342769	C7
342770	C6





1 SCREW (2 REQ'D)
 04751 PLATE } RH MODELS ONLY
 (ARROW ON PLATE POINTS UP)

MODEL	VALVE PLATE
PVB90-(F)RSF-20-C-10	295214
PVB90-(F)LSF-20-C-10	297951



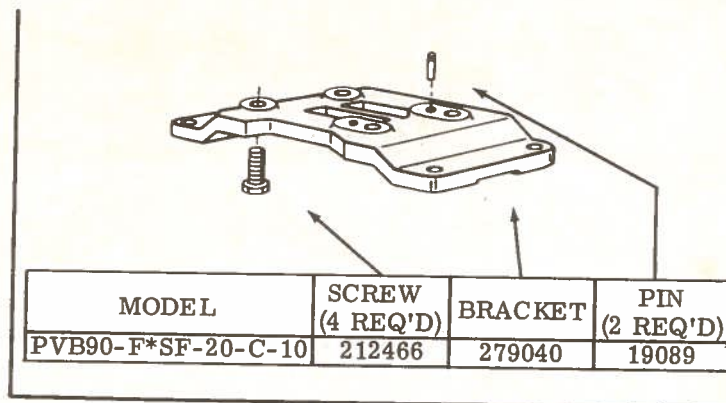
5012 YOKE SUBASSY
 SHIM (AS REQ'D)
 OBTAIN A CLEARANCE OF
 .006 INCH BETWEEN
 SHOE PLATE AND
 PLATE.)

SCREW (2 REQ'D)
 TO 190-210 lb. ft.)

▲ INCLUDED IN
 919506 SEAL KIT

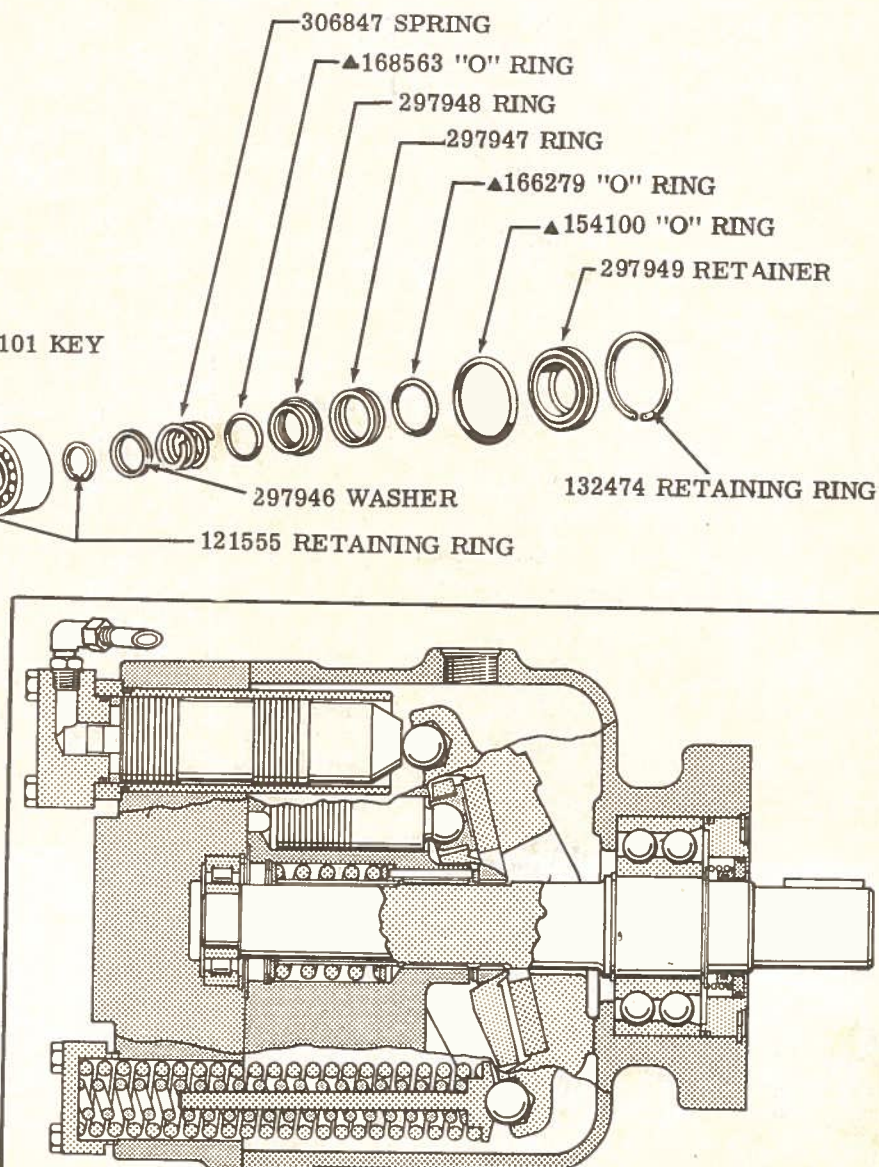
F3 EQUIVALENT
 SEAL KIT 920245

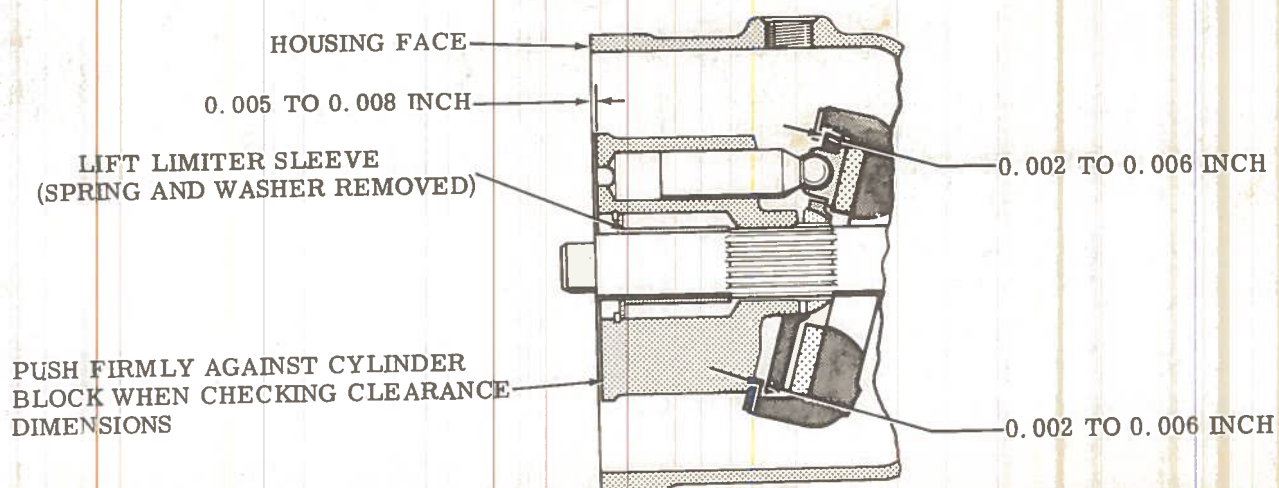
■ INCLUDED IN 938291
 ROTATING GROUP KIT



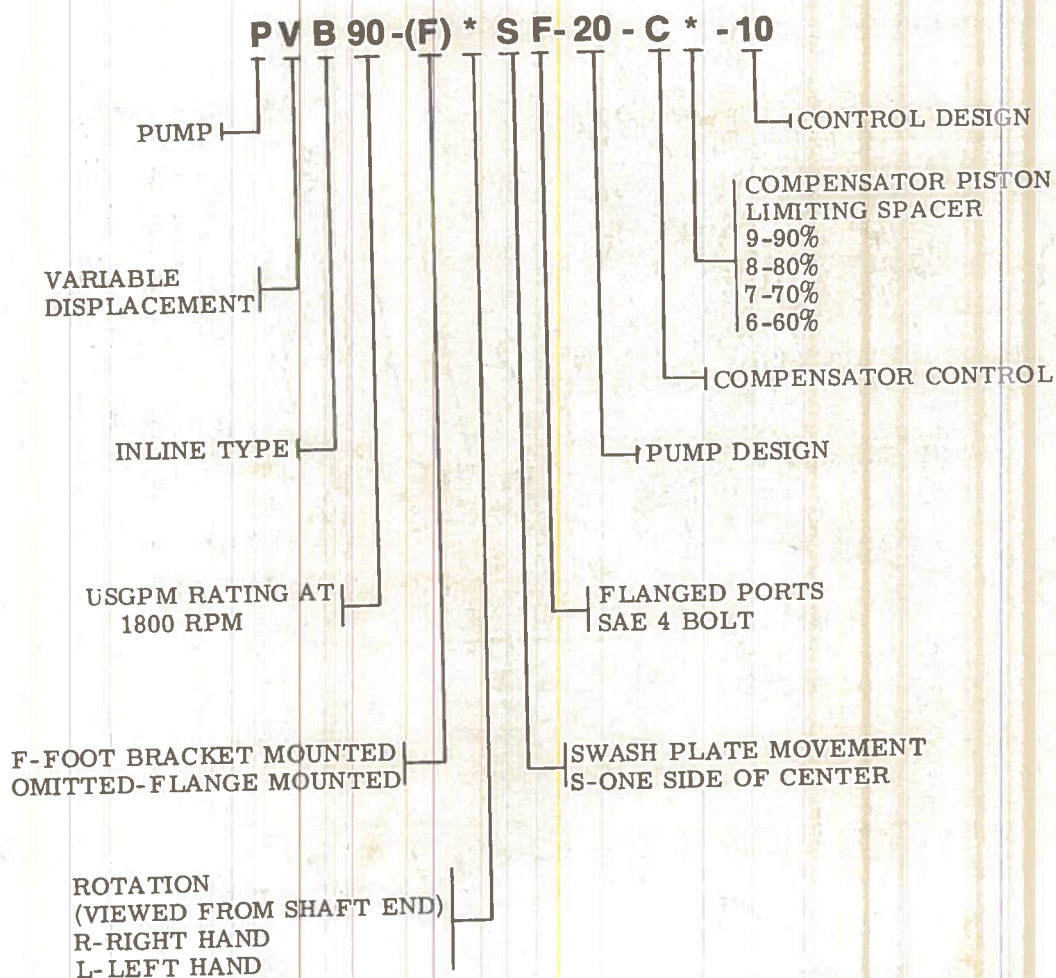
● COMPENSATOR KITS

TYPE	SPRING	KIT NO.
C	245087	941184
CM	285870	941185





MODEL CODE BREAKDOWN



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

65

INTRODUCTION TO THE HYDRAULIC TRAINER

NOTE: After completing the project, keep this work sheet with your other training materials as reference.

I. INTRODUCTION

The Hydraulic Trainer can be used to demonstrate many of the principles and circuits which have been discussed in the lectures. All of the components are the standard units as used on industrial applications.

A part of the trainer circuit is rigidly plumbed. This portion consists of the reservoir, pump, filters, restriction valve, bypass valve, aeration valve, and relief valve.

Hoses with quick-disconnect fittings make it easy to connect the other components into a circuit. Both the hoses and the fittings on the components contain check valves to prevent excessive oil spillage.

Although the hydraulic components are capable of operation at higher pressures, we limit the maximum operating pressure to 500 psi to prevent overloads on the electric motor. After familiarization, you are to check this maximum pressure.

II. FAMILIARIZATION

Identify the function and model number (if available) of the rigidly plumbed components shown in Figure 1.

Write the description in the spaces provided. Be as explicit as possible. For example:

NEEDLE VALVE

Opens pump inlet to atmosphere
to demonstrate aeration

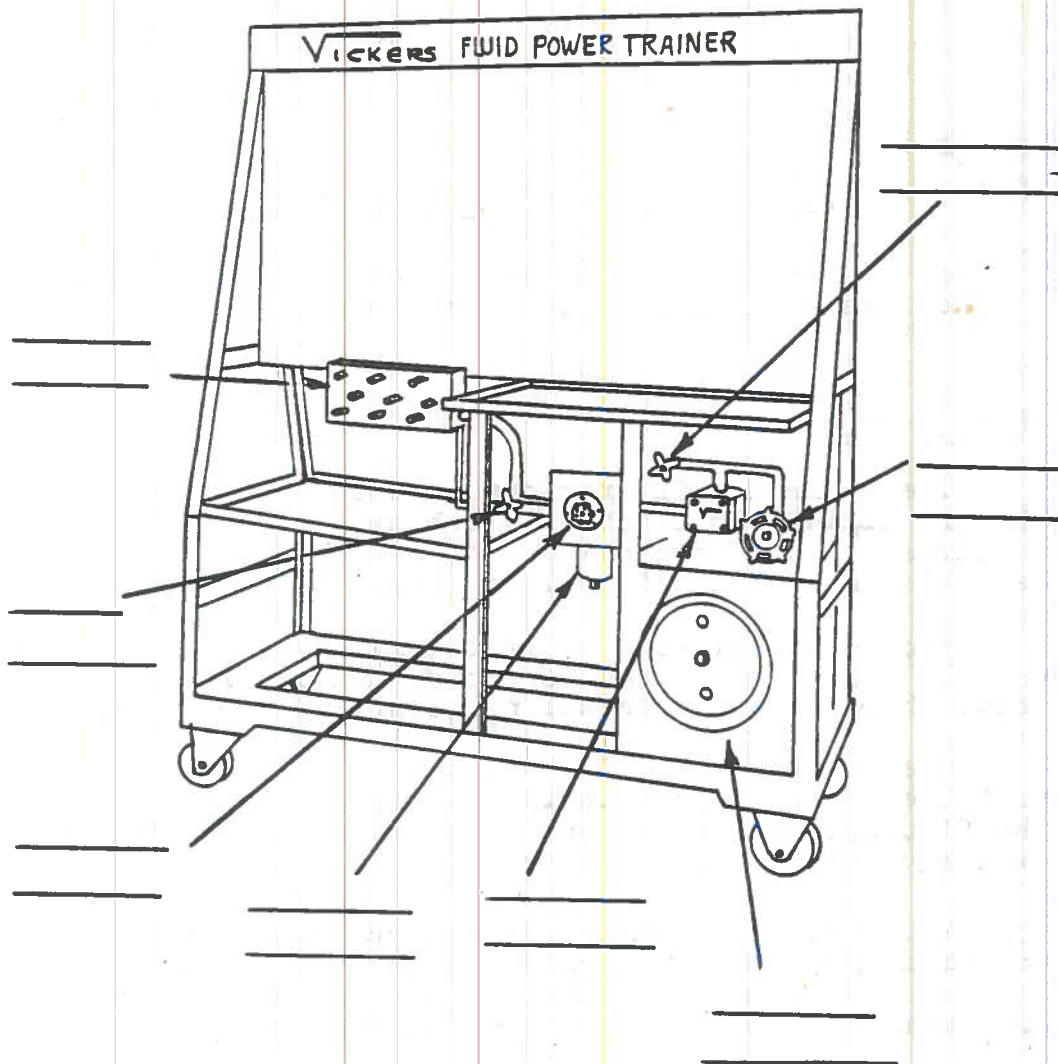


FIGURE 1. IDENTIFICATION OF COMPONENTS

III. CHECKING MAXIMUM PRESSURE

- A. Open the tank bypass valve.
- B. Identify the pressure gauge that is used to indicate system pressure.
- C. Plug the power cord into the 115 A.C. wall outlet and start the electric motor.
- D. Slowly close the bypass valve while observing the pressure gauge. Do not allow the pressure to exceed 500 psi. If it tends to be greater or is less, loosen the lock nut and adjust the relief valve until the pressure is 500 psi when the bypass is fully closed. Tighten the lock nut after the adjustment is made.
- E. Shut off the electric motor.

IV. RECIPROCATING CYLINDER WITH OPERATION AT TWO DIFFERENT MAXIMUM PRESSURES

- A. Complete the drawing shown in Figure 2. The purpose of the circuit is to reciprocate the vertical cylinder with the directional valve. In addition, the maximum pressure on the cap end is to be 200 PSI. The maximum pressure at the rod end is to be 500 PSI.
- B. Now connect the circuit on the trainer as you have drawn it. Extend the cylinder and adjust the pressure reducing valve to limit the pressure at the cap end to 200 psi. Retract the cylinder and observe the pressure reading on the other gauge.

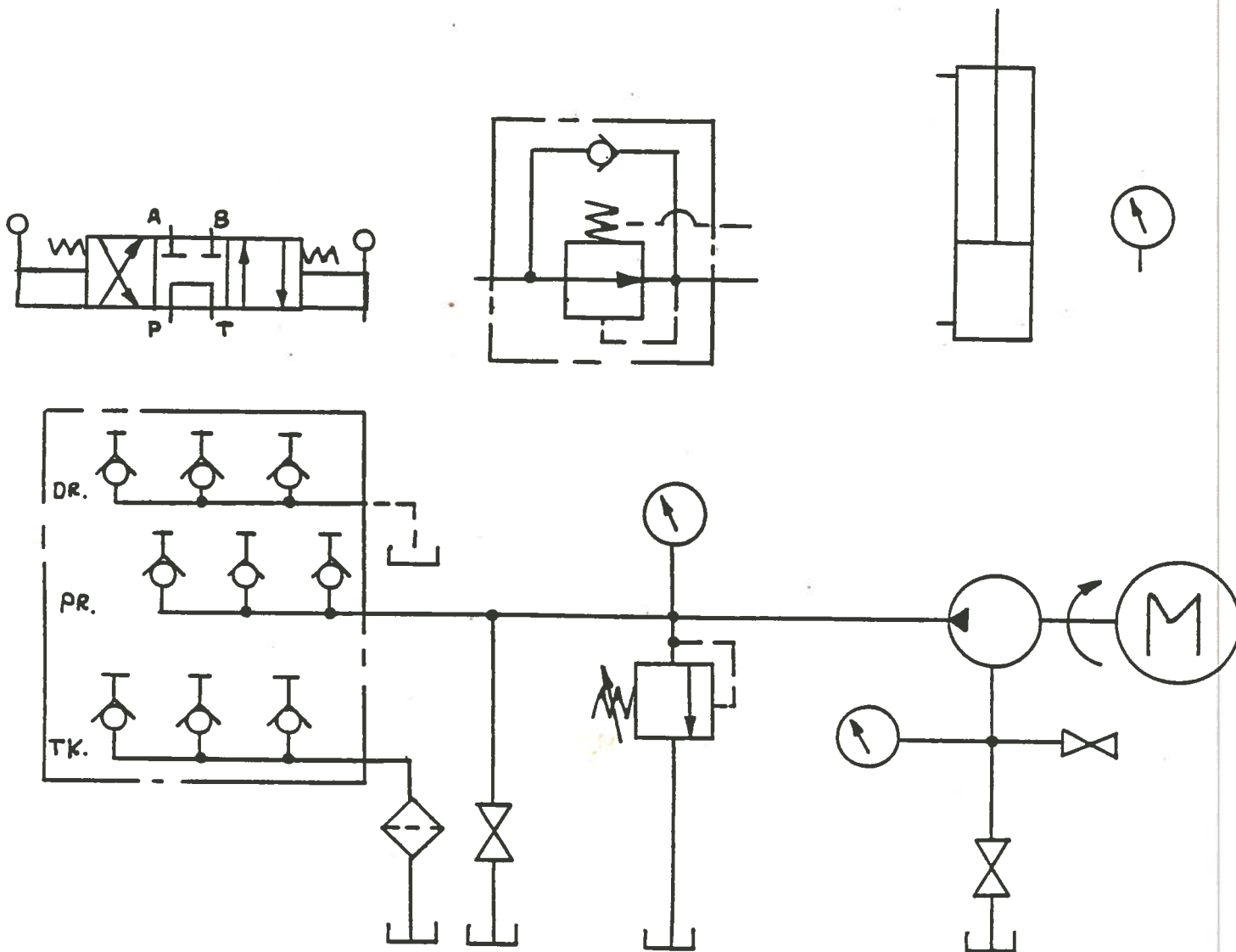


FIGURE 2. RECIPROCATING CIRCUIT

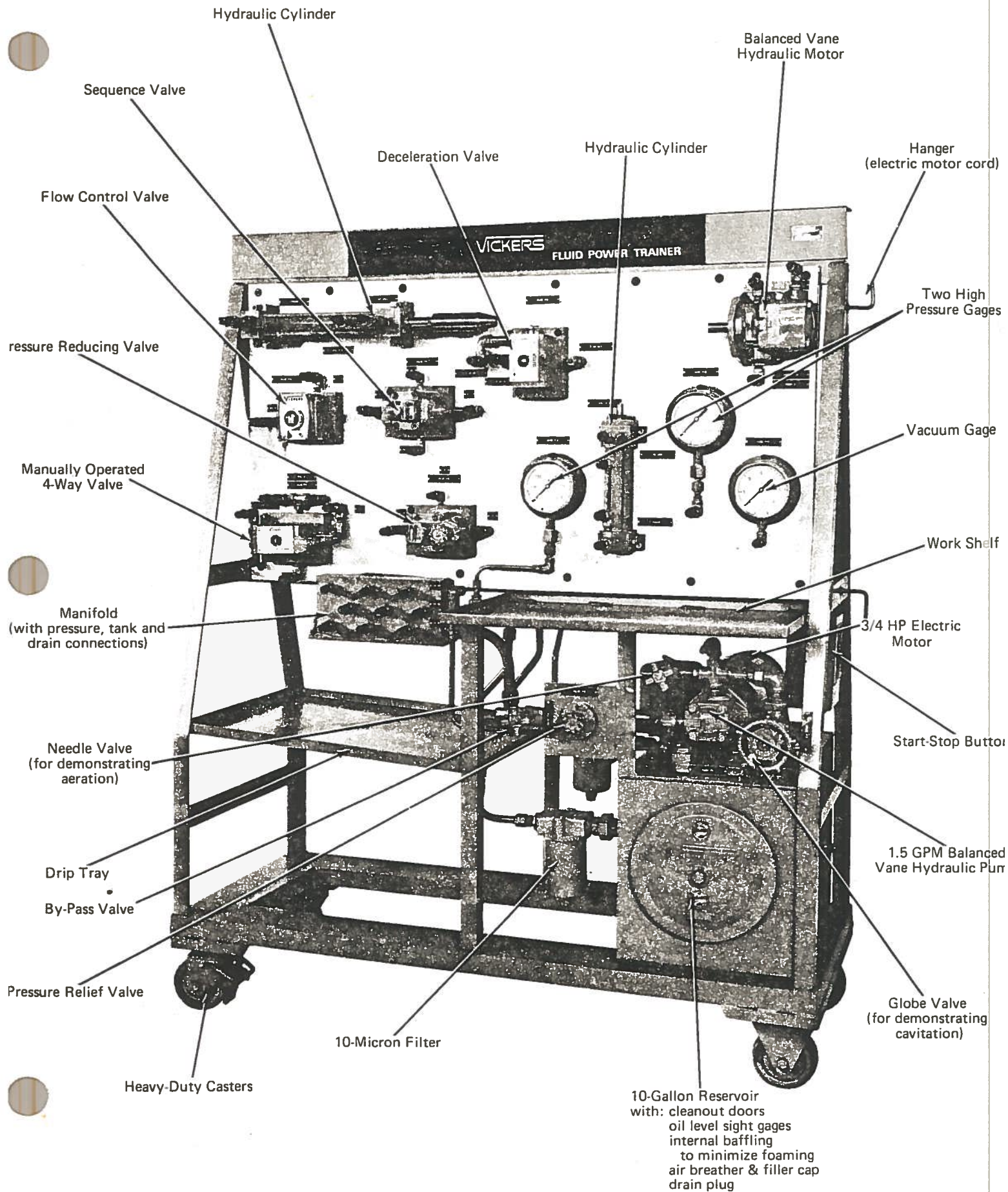
IV. QUESTIONS

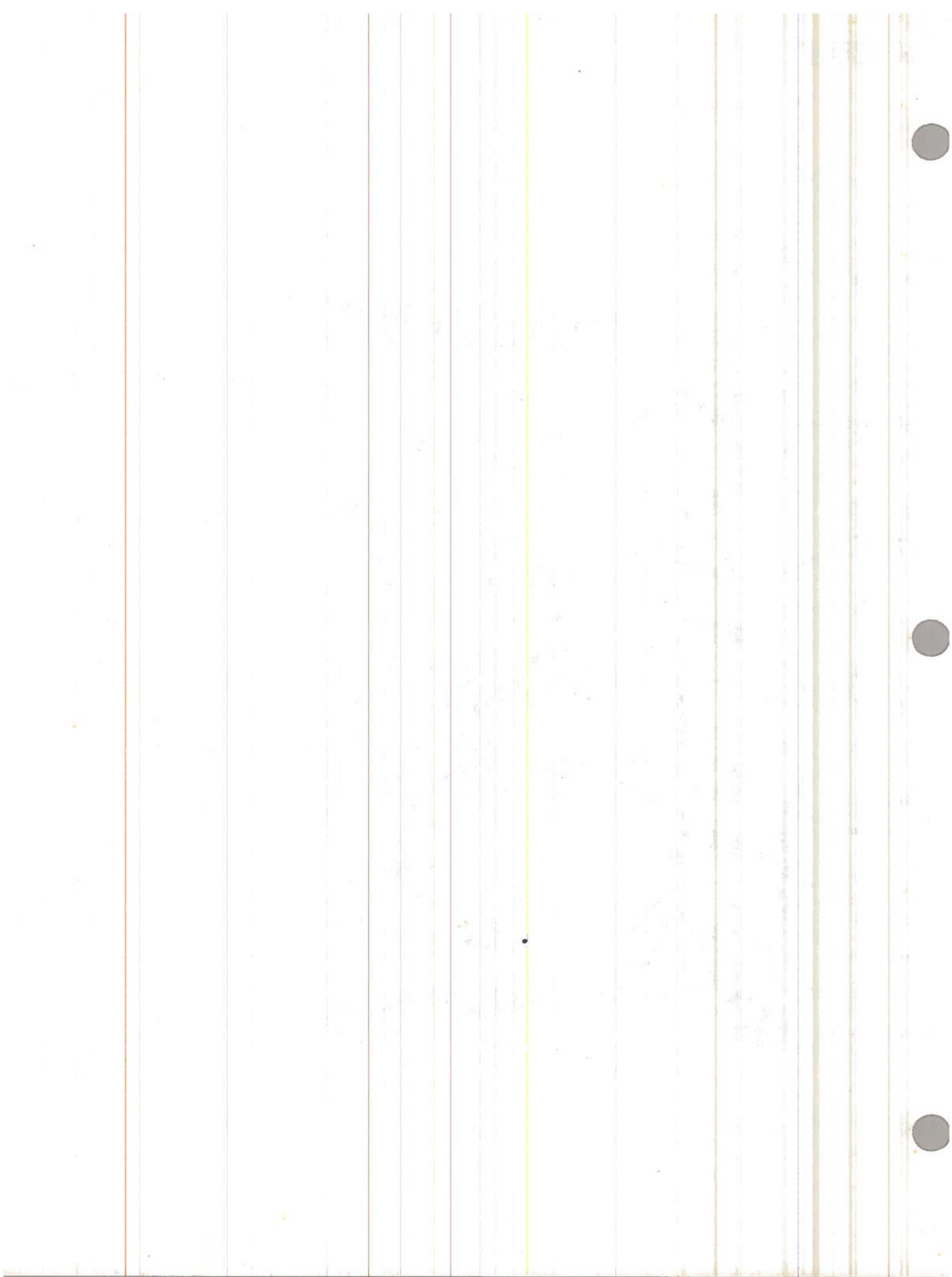
- (A) What is the minimum reduced pressure we can obtain at cap end of the cylinder in this circuit?
_____ PSI

What determines this pressure? _____

- (B) What is the maximum recommended setting of the reducing valve in this application with relief valve set at 500 PSI? _____ PSI

- (C) With the Trainer operating and 200 PSI at the cap of the cylinder, remove the drain connection at the manifold. What happens? Why? _____





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LABORATORY WORKSHOP
CARTRIDGE VALVES IN CONJUNCTION WITH THE FLUID POWER TRAINER

- I. To reciprocate the horizontal cylinder using a meter-out type speed control for control in both directions.
 - A. Assemble inserts and covers in manifold as shown in Figure #1. Note: That valve #1 and valve #4 require dampener inserts and stroke limiting covers.

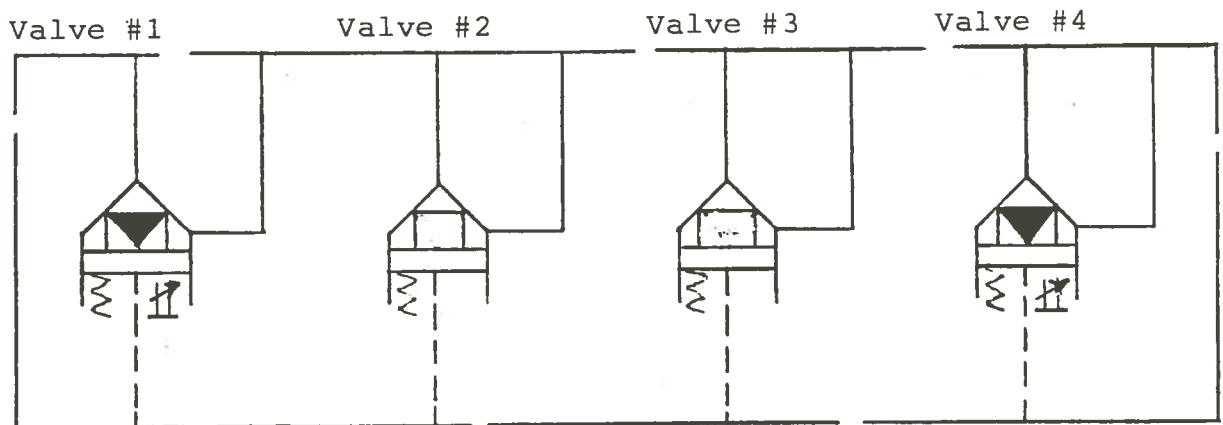


Figure #1

- B. Complete the drawing shown in Figure #2. The purpose of the circuit is to reciprocate the horizontal cylinder.
- C. Place the cartridge valve manifold on the hydraulic trainer tray directly beneath the hydraulic trainer manifold. Connect the circuit as you have drawn it. Before start up, back out the stroke limiter adjusting screws to permit maximum piston rod velocity. Observe piston rod velocity in both directions.
- D. Adjust stroke limiting controls decreasing the piston rod velocity in both directions.

1	2	3	4
c	c	c	c
c	o	c	o
o	c	o	c
c	o	o	c

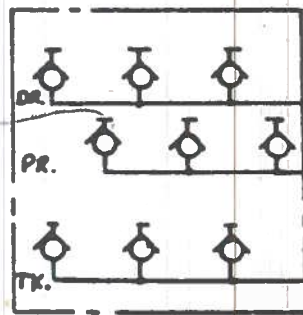


Figure #2

c	c	c	c
c	o	c	o
c	o	o	c

69

Page 3 of 4

Problem - With the addition of a second directional control valve arrange the circuit to permit regenerative advance with changeover to conventional.

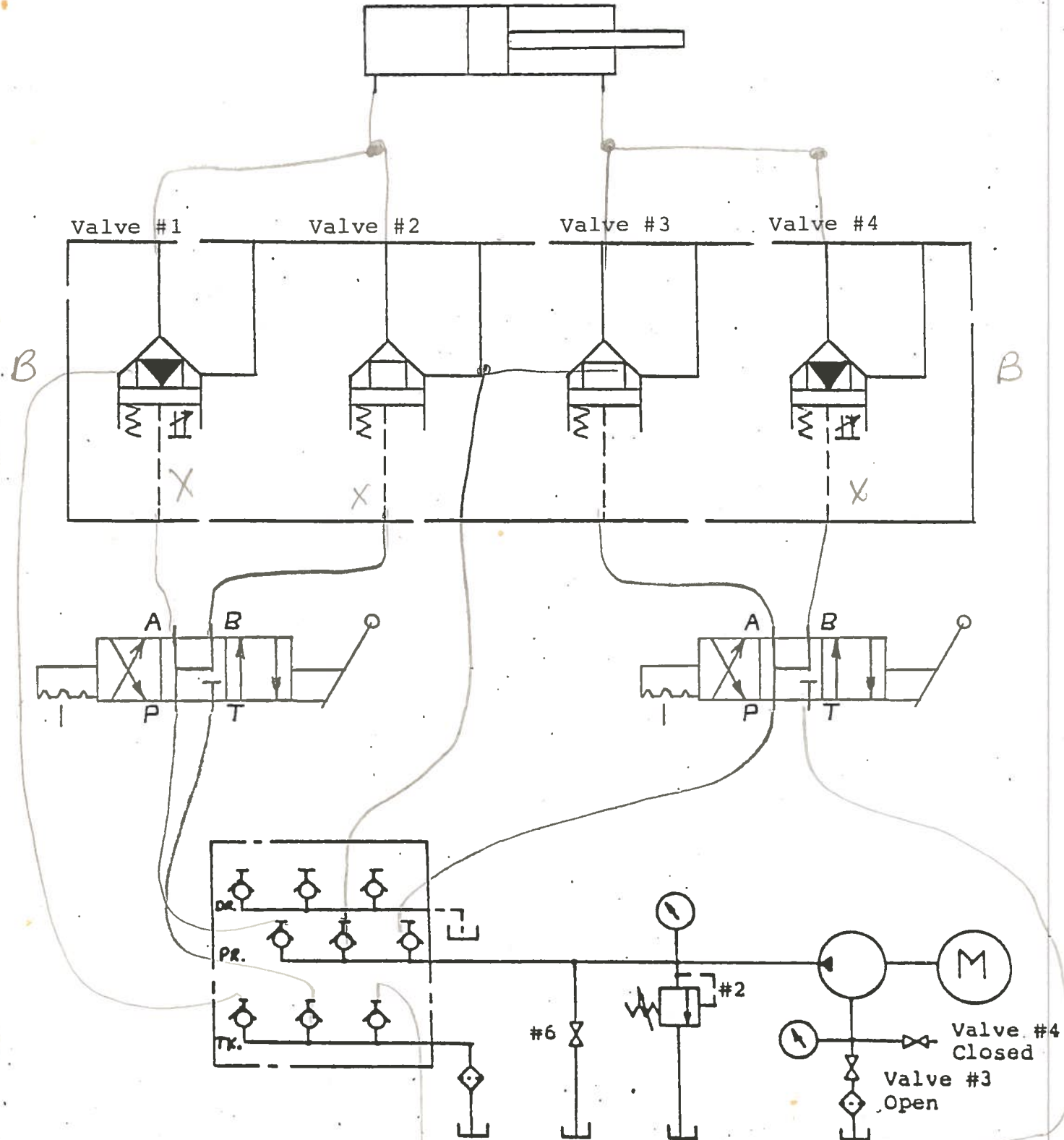


Figure #3

- A. Indicate the four equivalent directional valve spool positions in this circuit. Graphic symbols.
- B. Remove and hang up the hoses. Leave the manifold on the trainer for future use. Thank you.

70



-LABORATORY WORK SHEET-

CIRCUITS USING CARTRIDGE VALVE
TYPE PRESSURE AND FLOW CONTROL

I. Circuits using a cartridge valve as a relief valve.

A. Assembly of relief valve

Assemble using the single valve test manifold, 1:1 area ratio insert and relief valve cover. Identify all the manifold ports. After assembly is complete, turn adjustment to minimum pressure position. Place manifold on hydraulic trainer tray.

II. Checking maximum pressure of hydraulic trainer.

- A. Open the tank bypass valve #6 and start the electric motor. Slowly close the bypass valve while observing the pressure gauge. Do not allow the pressure to exceed 500 PSI. If it tends to be greater or if less, loosen the locknut and adjust the relief valve #2 until the pressure is 500 PSI when the bypass is fully closed. Tighten the locknut after the adjustment is made. Now open bypass valve and shut off electric motor.

III. Complete the drawing shown in Figure #1.

- A. The purpose of the circuit is to allow the cartridge valve to limit maximum pressure in the system.
- B. Now connect the circuit on the trainer as you have drawn it. With the bypass valve #6 open, start the electric motor. Then as you watch the system pressure gauge, slowly close the bypass valve #6. Now adjust the cartridge relief valve to 350 PSI. Open and close the bypass valve. Does pressure return to 350 PSI on closing? If so, tighten lock nut on adjustment, then open bypass valve.
- C. Add a hose from Z1 port to manifold drain connection and close bypass valve #6. What pressure does system pressure gauge read?
- _____ PSI
- Why? _____
- _____
- _____
- _____
- D. Disconnect the hoses from the valve before starting next circuit.

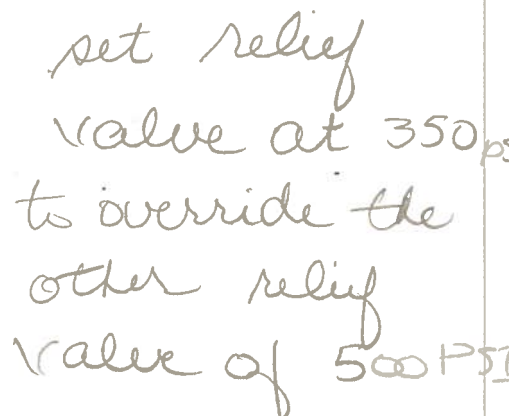


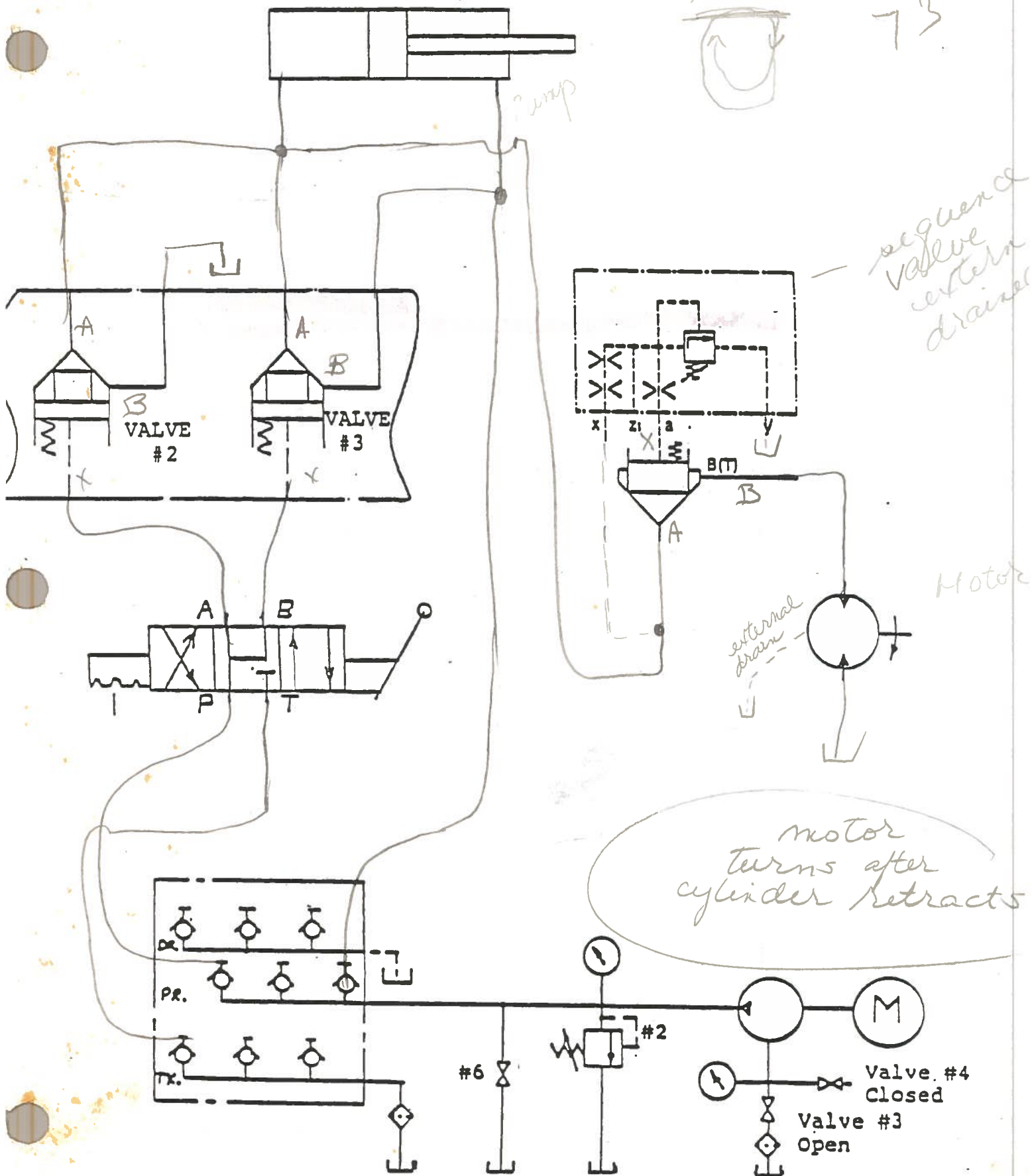
FIGURE #1

- IV. Complete the drawing in Figure #2. Note that the 1:2 ratio inserts shown are in the four element manifold.

Purpose - sequence operation:

- 1) Extend cylinder #12 fully.
- 2) Start hydraulic motor when cap end pressure reaches 350 PSI.
- 3) During retraction of the cylinder the hydraulic motor must be stopped. Cylinder to retract at same speed as extended.

- V. Remove cartridge valve pressure control from the hydraulic trainer and return it to the work bench. Remove the cover and insert. Replace with the pressure reducing insert and cover.



VI. Reciprocating cylinder with operation at two different maximum pressures:

- A. Complete the drawing shown in Figure 3. The purpose of the circuit is to reciprocate the vertical cylinder with the directional valve. In addition, the maximum pressure on the cap end is to be 200 PSI. The maximum pressure at the rod end is to be 500 PSI.
- B. Now connect the circuit on the trainer as you have drawn it. Extend the cylinder and adjust the pressure reducing valve to limit the pressure at the cap end to 200 PSI. Retract the cylinder and observe the pressure reading on the other gauge.

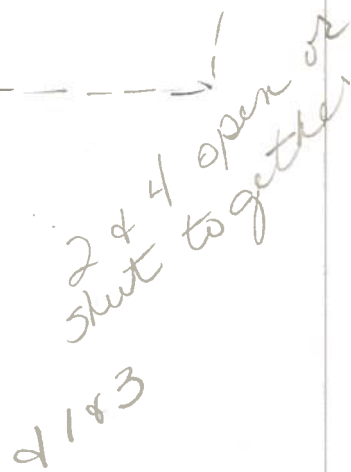


FIGURE # 3

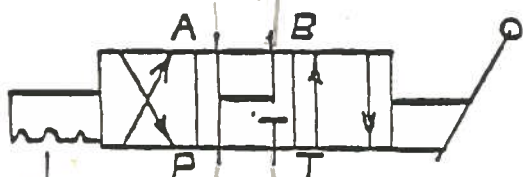
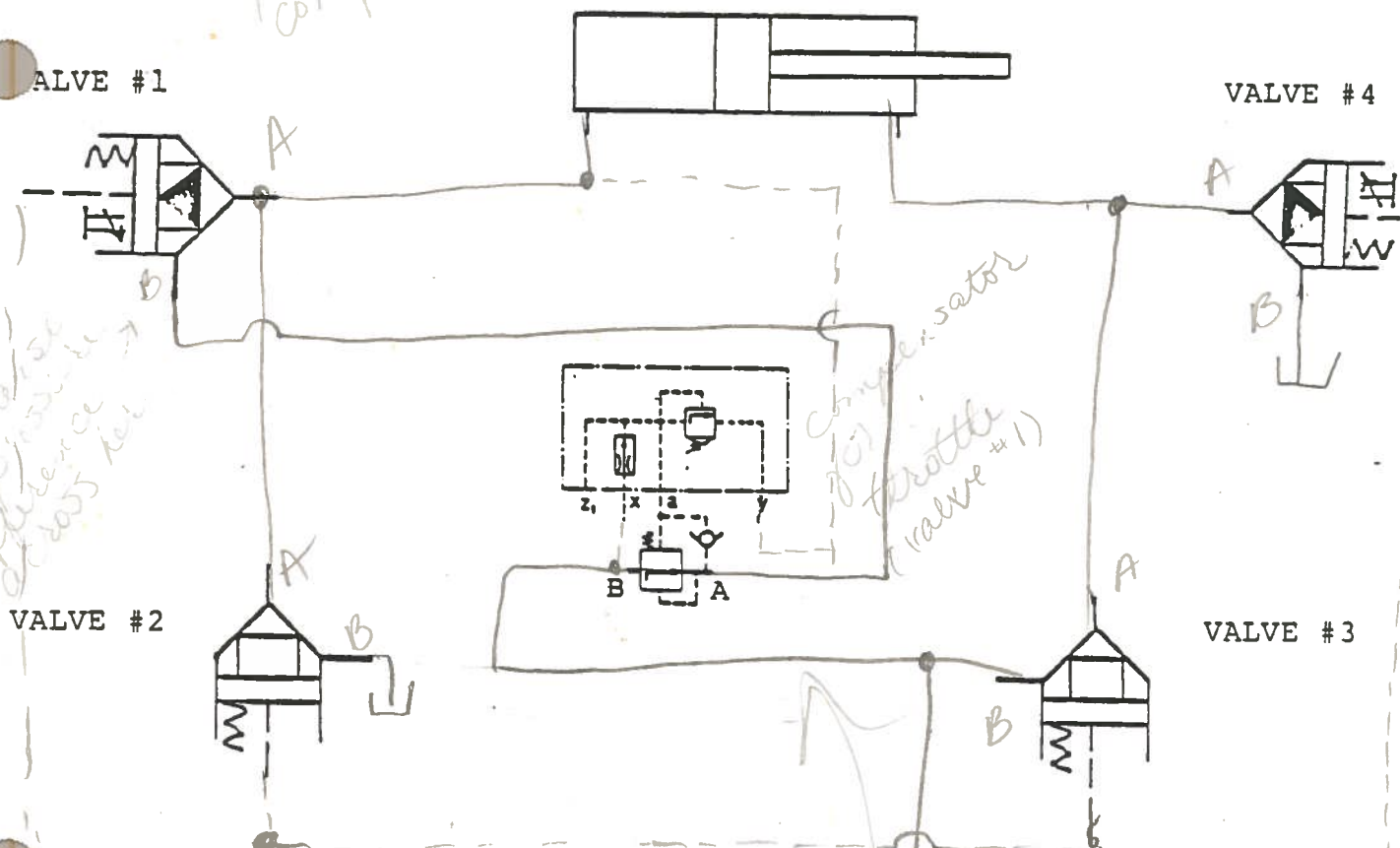
VII. Pressure compensated restrictor type flow control:

- A. Using valve #1, connect the pressure reducing valve to act as the pressure compensator of your flow control.
- B. Complete the drawing in Figure #4. The purpose of the circuit is to provide a choice of extension speeds by controlling the flow of fluid into the cap end of the cylinder.
- C. When cylinder is completely extended, what is maximum pressure?
_____ PSI. Is it adjustable? _____
- D. What determines maximum retraction pressure?

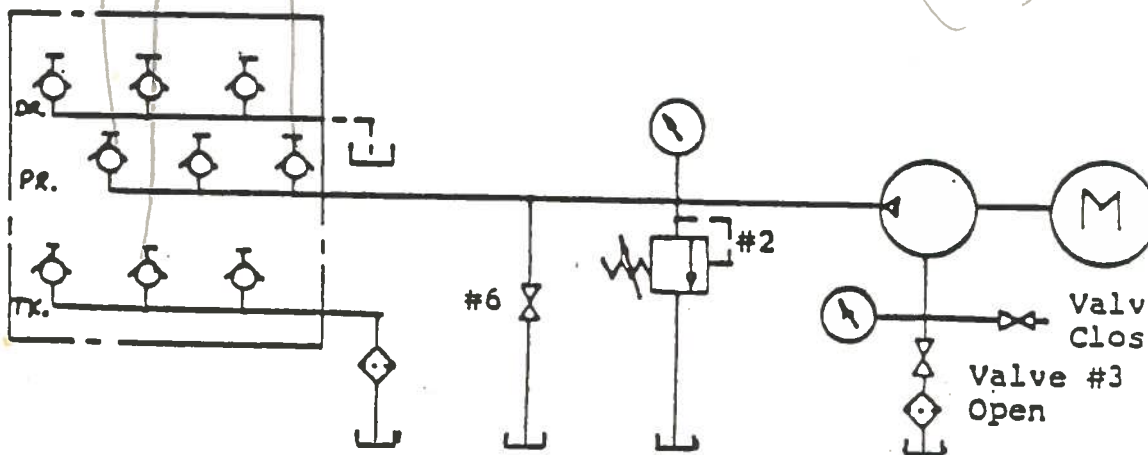
- E. When you have completed this problem, please return all hoses to the rack.

Pressure compensator

95



Pressure compensator





The following figures are the full-stroke displacements of the poppets for the 1:2 and 1:1.1 ratio cartridge valve inserts:

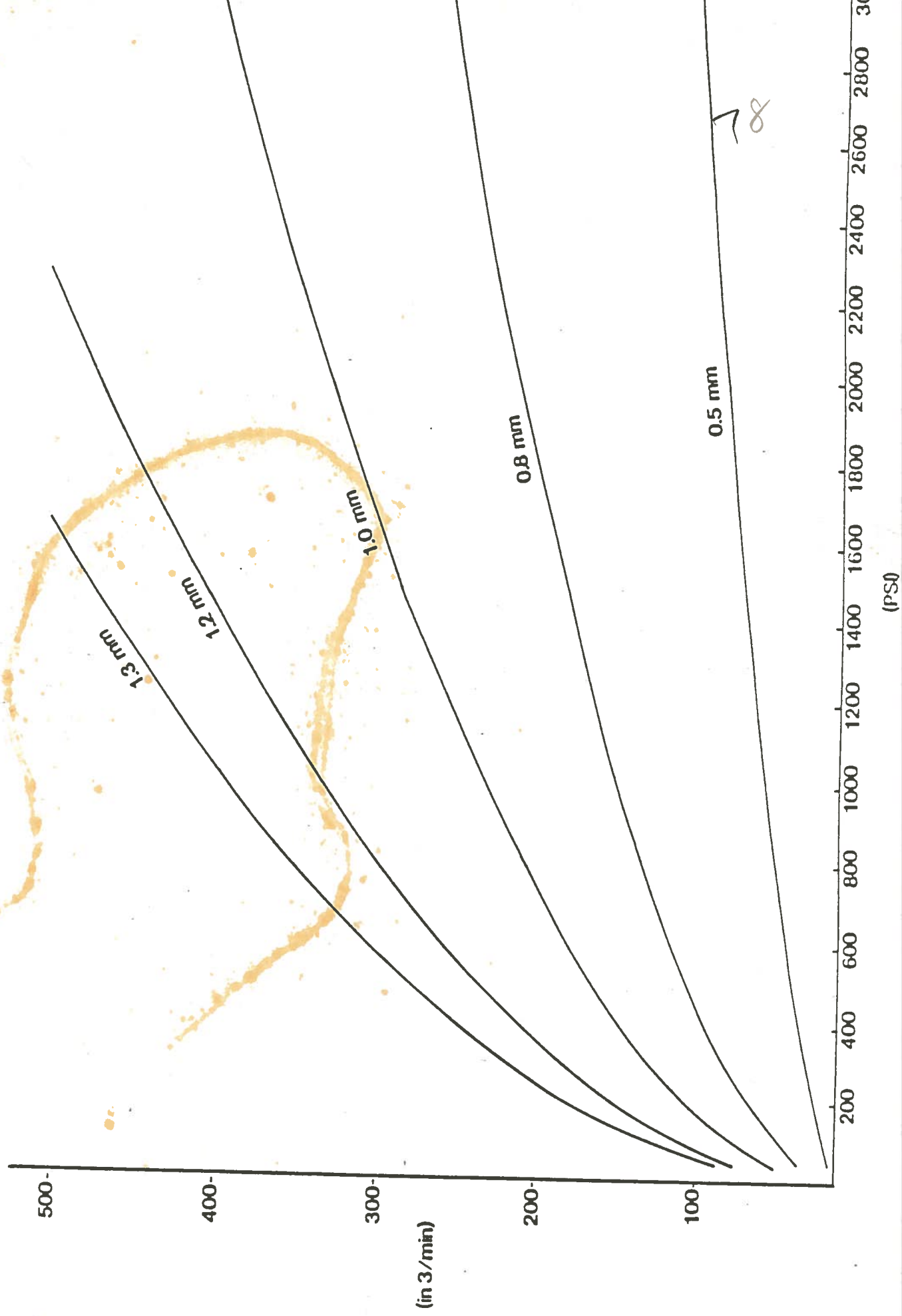
16mm	-	Spool (AP) area	0.33 in ²
		Stroke	0.21 in
		Displacement	0.07 in ³
25mm	-	Spool (AP) area	0.76 in ²
		Stroke	0.36 in
		Displacement	0.27 in ³
40mm	-	Spool (AP) area	2.05 in ²
		Stroke	0.48 in
		Displacement	0.98 in ³
50mm	-	Spool (AP) area	3.29 in ²
		Stroke	0.68 in
		Displacement	2.23 in ³
63mm	-	Spool (AP) area	5.30 in ²
		Stroke	0.84 in
		Displacement	4.46 in ³

These figures can be used with the attached orifice diagram to approximate the opening and closing times of the poppets with different size orifices. For example, if there is a 2000 psi ΔP across a 0.5mm orifice in a 25mm valve, the poppet will travel its full stroke in about 200 milli-secs.

$$\frac{(.27 \text{ in}^3) (60 \text{ sec/min})}{(80 \text{ in}^3/\text{min})} = .200 \text{ sec.}$$

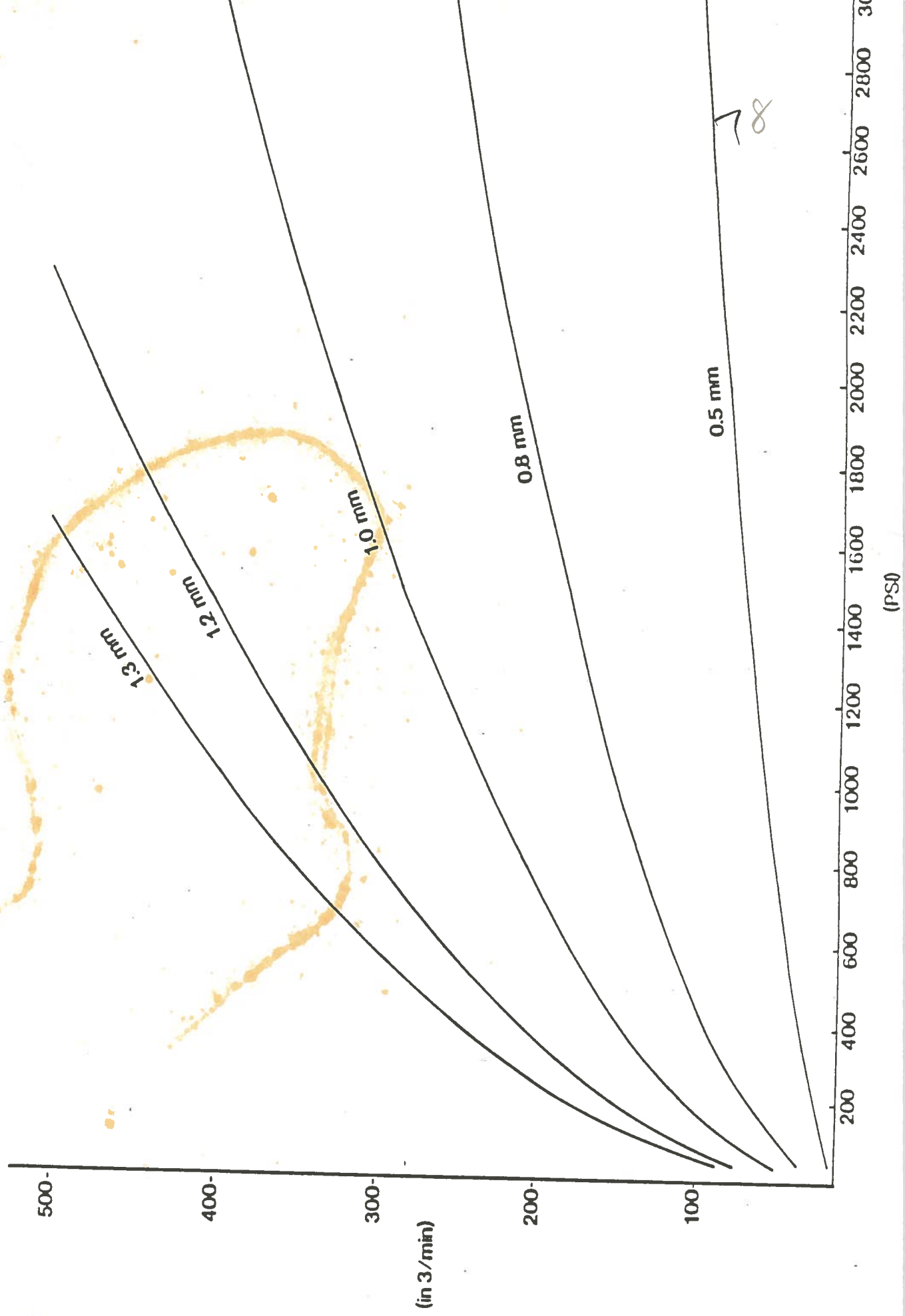
These can be used as starting points in determining the right orifice selection for your application. The final determination is, of course, still the application itself and the fine tuning is done on the machine.

OIC DIAGRAM





OC. DIAGRAM





Cartridge valves to DIN 24342

Electro-hydraulic proportional restrictor valves
and pressure compensated flow controls

Basic characteristics

Nom. sizes NG16, NG25 and NG40
Max. operating pressure 350 bar
Max. controlled flow rate
... up to 1200 l/min
Repeatability $\pm 0,5\%$

3. Operating data:

• Pressure limits	3
• Flow limits	3
• Electrical data	3
• Performance characteristics ..	3
• Electronic control system ...	5
• Hydraulic fluids	5
• Temperature limits	5
• Filtration requirements	5

4. Installation dimensions

and part numbers	6
------------------------	---

5. Mass

.....	7
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6. Installation data

.....	7
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7. Ordering procedure

.....	7
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Contents

Page

1. General description	1
2. Functional symbols	1

1. General description

Restrictor valves, sizes NG 16, NG 25

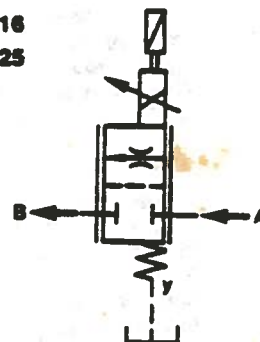
These valves are direct operated by a proportional solenoid and have positional feedback of the spool by means of a position sensor. The valves are of the normally closed non-pressure compensated type and designed such that the restrictor opening is proportional to the electrical input signal.

Function of the position control

The proportional solenoid is integrated in a closed loop position control. The electrical reference input energizes the solenoid and continuously opens the flow path against the spring force. The inductive sensor detects the armature's position and provides feed-back for the control loop.

2. Functional symbols

NG 16
NG 25



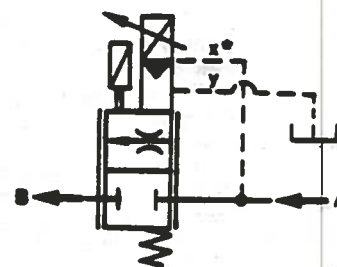
Restrictor valve, size NG 40

This valve is pilot operated by a proportional solenoid device controlling the main spool. The main spool is connected to a position sensor to provide positional feedback. The valve is of the normally closed non-pressure compensated type and designed such that the restrictor opening is proportional to the electrical signal applied to the pilot stage.

Function of position control, NG 40

A spring retains the main spool in the closed position thus blocking flow. The proportional solenoid is integrated in a closed loop spool position control. The electrical reference input energizes the solenoid which continuously operates the pilot valve. This reduces pilot pressure in the main spool spring chamber against input pressure until the desired opening is achieved. The inductive sensor detects the main spool's position and provides feed-back for the control loop.

NG 40



Position sensor (all sizes)

The inductive position sensor transmits a continuous feed-back signal to the electronic control unit. This signal is proportional to the flow path opening. The control unit compares this signal with the reference input and regulates the solenoid current accordingly. The use of heavy duty proportional solenoids provides fast response to any kind of disturbance and immediate cor-

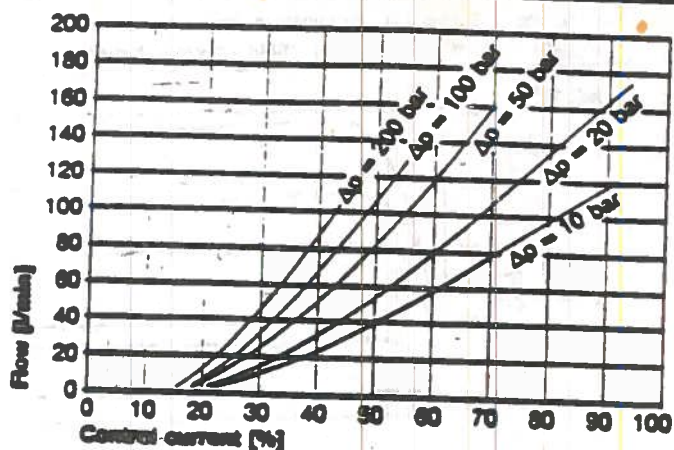
rection of differences between input and feed-back signal.

"Pilot control port 'x' must be connected directly to the main port 'A'. Control by any other external pressure source is not permitted.

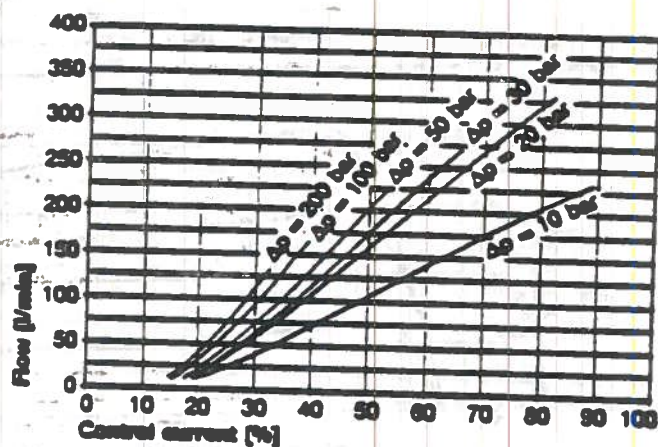
Performance characteristics (cont.)

Flow/control current curves

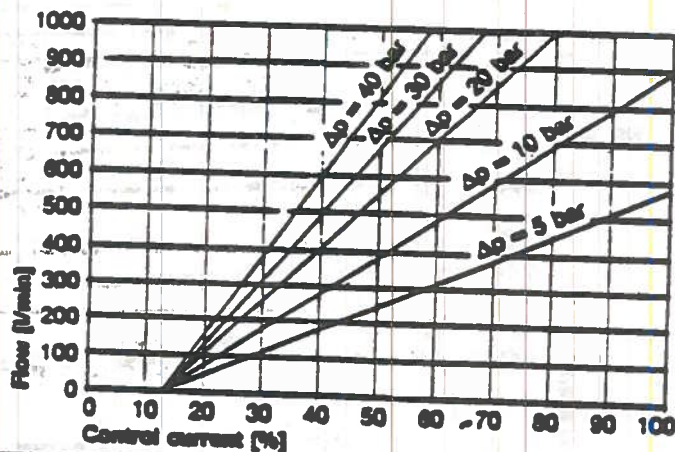
NG 16



NG 25



NG 40



Restrictor valve leakage, typical (Closed position $\Delta p = 100$ bar)

NG 16 A-B	1.0 l/min
NG 16 A-Y	0.5 l/min
NG 25 A-B	2.0 l/min
NG 25 A-Y	0.8 l/min
NG 40 A-B	1.0 l/min

Response time

at a input signal step 0 to 90%

NG 16	100 ms
NG 25	100 ms
NG 40	180 ms

Frequency response

at 90° phase shift

NG 40	8 Hz
-------	------

Hysteresis Δ

NG 16	$\pm 1.5\%$
NG 25	$\pm 1.5\%$
NG 40	$\pm 0.5\%$

Repeatability

at constant Δp and constant viscosity:

NG 16	$\pm 0.5\%$
NG 25	$\pm 0.5\%$
NG 40	$\pm 0.5\%$

Deviation from linearity Δ

NG 16	$\pm 4\%$
NG 25	$\pm 4\%$
NG 40	$\pm 0.5\%$

Δ Applies to the complete length of the spool stroke.

Electronic control system

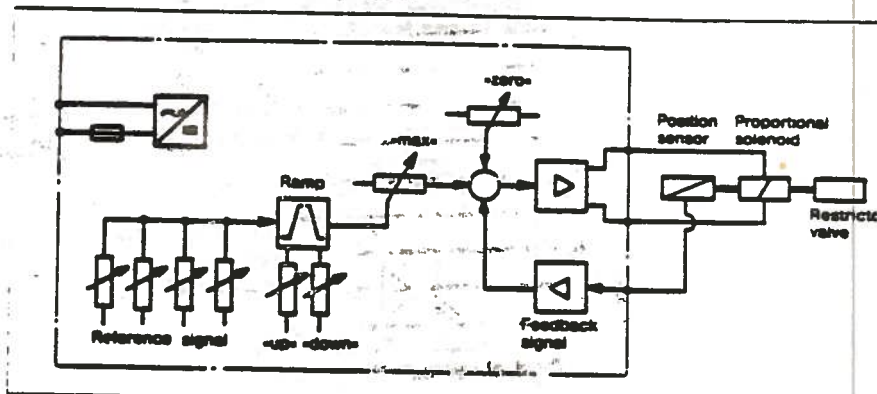
Closed loop solenoid control

A special electronic unit is necessary to operate and control the proportional solenoid. It has to match the complete control loop. Sperry Vickers supplies these units in the following versions:

Electronic control unit for directly operated proportional restrictor valves NG 16, NG 25

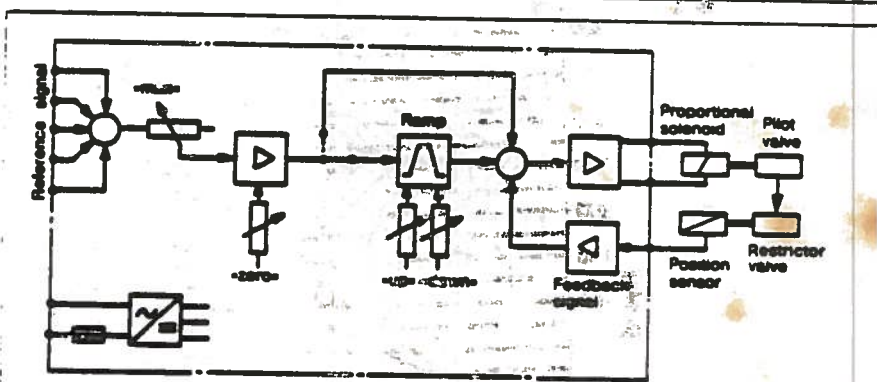
1. Eurocard with a plug connector to DIN 41612/Form D/32 terminals/indirect and a separate transformer. Single mounting as an accessory. For detailed information see our technical information leaflet V-1010.

2. Model SV1L installed into a body cover, complete and including power supply. See technical information leaflet V-1009 for detailed information.



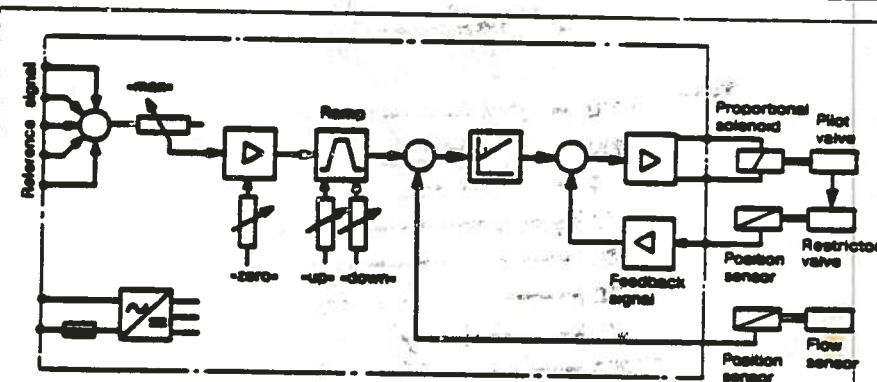
Electronic control unit for pilot-operated proportional restrictor valves NG 40

Model AN121, kit number 988914, Eurocard with a plug connector to DIN 41612/Form D/32 terminals/indirect and a separate transformer. Detailed information on request.



Electronic control unit for flow restrictor functions with flow sensor

This function is controlled by two separate position sensors and a special electronic unit. Description and technical details on request.



Hydraulic fluids

All cartridge valves can be used with anti-wear hydraulic oils, water-in-oil emulsions, water glycols and certain low viscosity fluids. Add prefix "F3" to model designations when phosphate ester (not alkyl-based) or chlorinated hydrocarbons are to be used. The extreme viscosity range is from 500 to 5 cSt but the recommended running range is from 54 to 13 cSt. For further information about fluids, see data sheet GB-V-920.

Temperature limits

Ambient min -20°C
Ambient max +70°C

Fluid temperatures

	Mineral oil	Water-containing
Min.	-20°C	+10°C
Max.*	+80°C	+54°C

*To obtain optimum service life from both fluid and hydraulic system, 65°C normally is the maximum temperature except for water-containing fluids.

For synthetic fluids consult manufacturer or Sperry Vickers where limits are outside those for mineral oil.

Whatever the actual temperature range, ensure that viscosities stay within the limits specified in the "Hydraulic fluids" section.

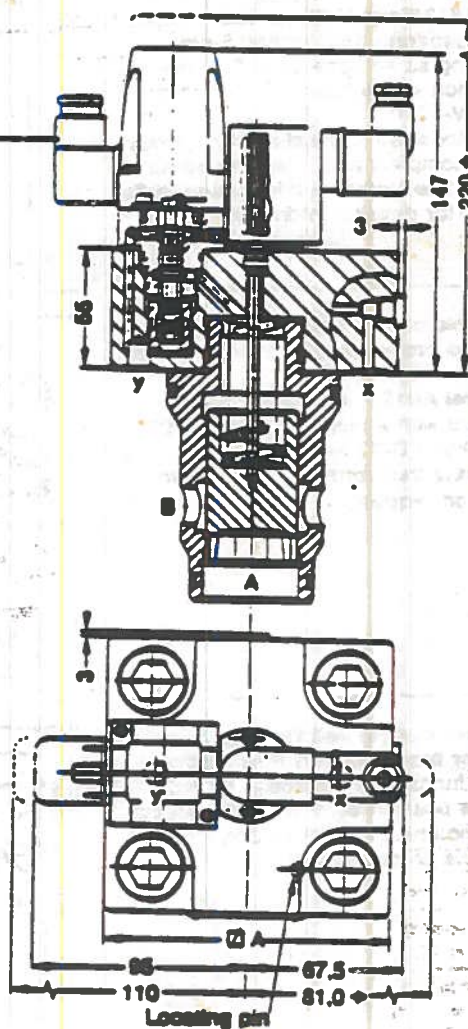
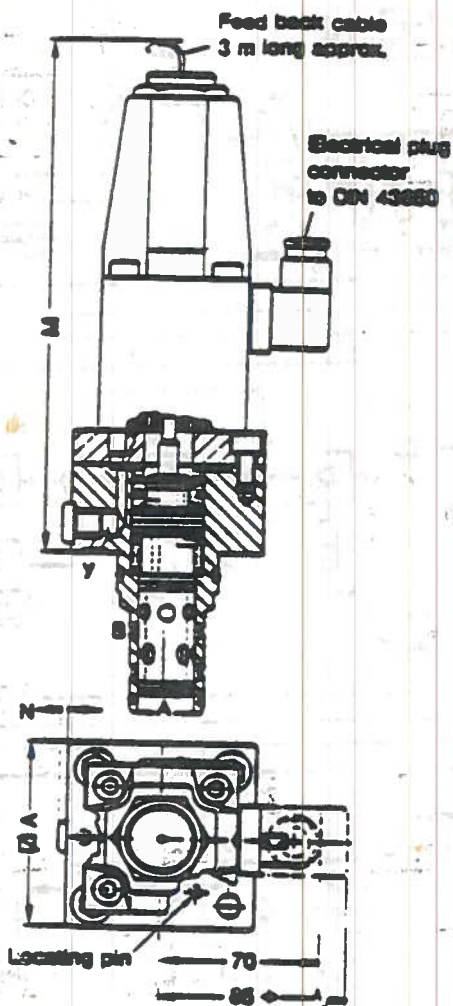
Filtration requirements
25 µm absolute or finer.

4. Installation dimensions and part numbers (in mm)

1st angle projection

Proportional restrictor valves
NG 16 and NG 25

Proportional restrictor valve
NG 40



The mounting position of the top cover around the insert's access is unrestricted.

Dimensions [mm]

Norm. size	K2 number	□ A	B	C	F	G +	H	J +	K	L	M	N	O	P +	Screw	Max. hole size	Torque tightness for fixing screws [Nm]
NG 16	813103	65	46	26	114.5	155	10	57	4	-	210	3	35	44	M 8	6 mm	35
NG 25	814596	85	51	28	105.0	146	10	66	4	-	240	4	42	53	M 12	10 mm	110
NG 40	967002	125	61	34	116.0	157	3	76	3	3	-	-	61	76	M 20	17 mm	500

+ Max. for withdrawal

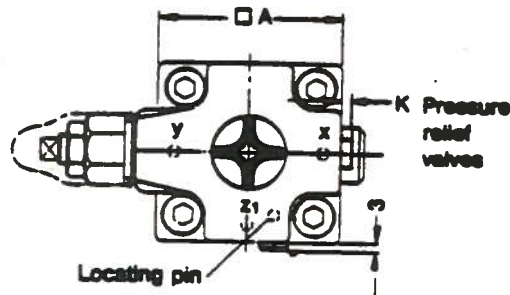
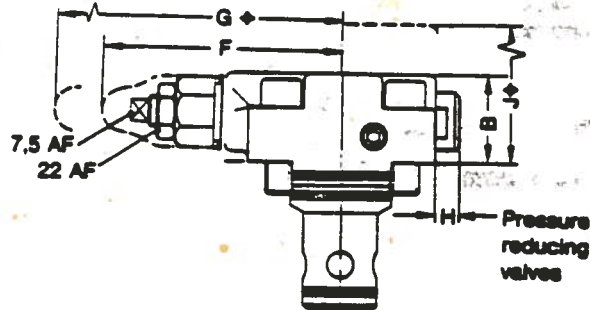
Notes: 1. For further installation information, see page 7, "Installation data"

2. For DIN 24342 stepped recess dimensions, see "Cartridge valves" leaflets GS-V-1502 or 1503

Installation dimensions and part numbers (cont.)

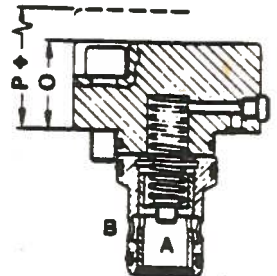
Hydrostats

Pressure relief and reducing valve types ▲
NG 16, NG 25, NG 40

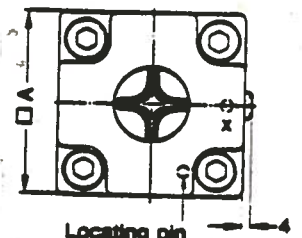
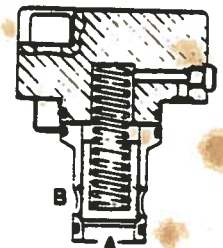


Spool and poppet types ♦
NG 16, NG 25, NG 40

Spool type



Poppet type



Kit numbers

Nominal size	NG 16	NG 25	NG 40
Pressure reducing valve type Adjustment range: 5-125 bar	764147	764285	986365
Pressure relief valve type Adjustment range: 5-125 bar	764479	764523	763081
Poppet type $\Delta p = 10$ bar	on request	on request	on request
Spool type $\Delta p = 10$ bar	814068	813616	on request

▲ For full details see "Cartridge valve" leaflets:
GB-V-1502 for relief valves
GB-V-1503 for reducing valves
♦ For full details consult your Sperry Vickers representative.

5. Mass (approx.)

763081	8.0 kg
764147	2.0 kg
764285	3.0 kg
764479	2.0 kg
764523	2.8 kg
813103	3.2 kg
813616	2.1 kg
814068	1.2 kg
986365	5.7 kg
987002	8.2 kg
	8.5 kg

6. Installation data

Mounting attitude Unrestricted

Relative location of cartridges

No restriction except that to ensure stable performance in each of the systems on page 2 related cartridges etc. should be as close to each other as practicable.

7. Ordering procedure

Ask your Sperry Vickers representative to present a quotation for a cartridge valve system tailored to your application or order individual cartridges by the kit numbers shown above.

40 40 40

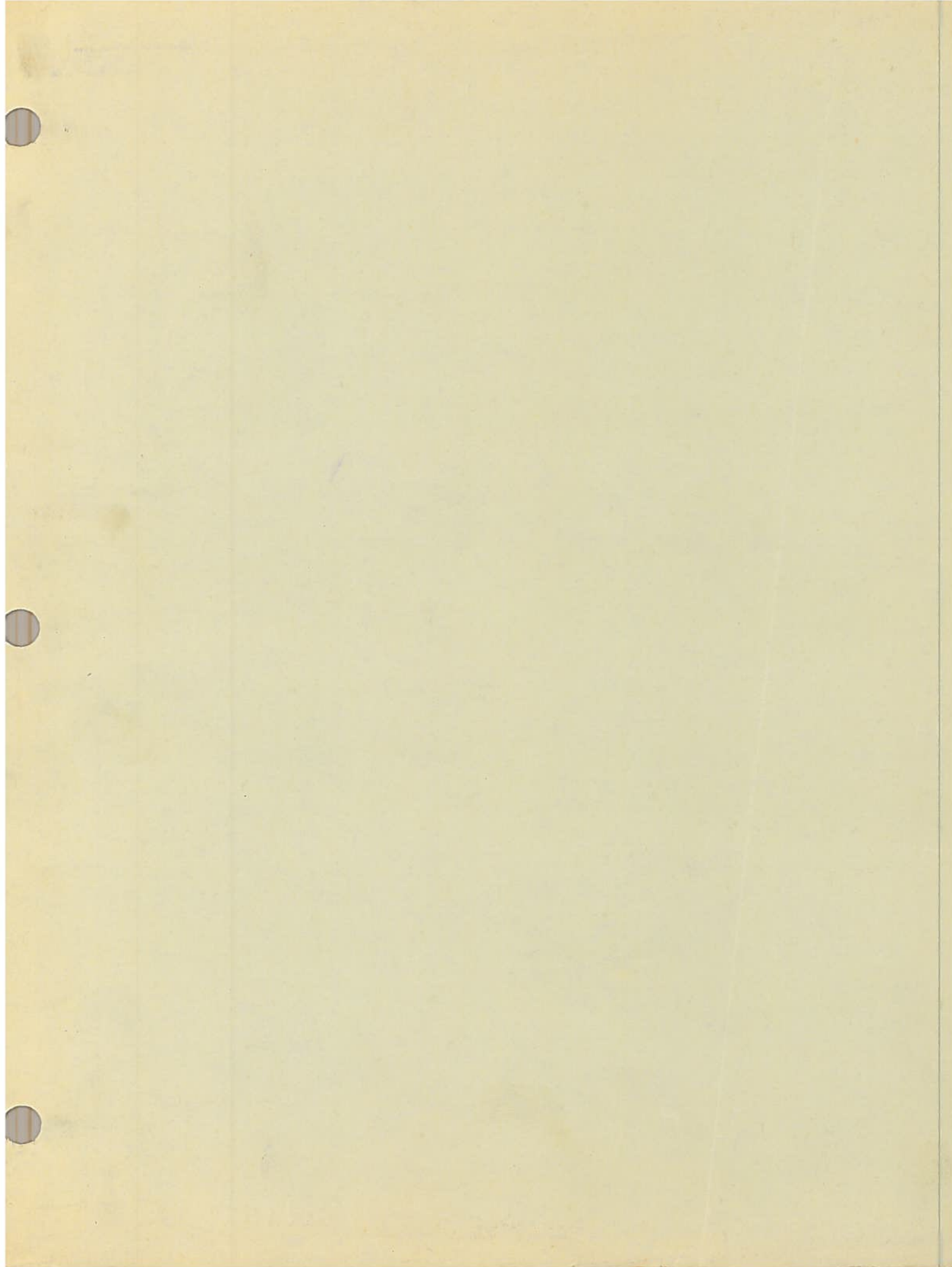
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GENERAL INFORMATION

Vickers Technical Training Center
1332 Anderson Road
Clawson, Michigan 48017

TELEPHONE

Our phone number is (313) 280-3381. You are welcome to make calls that are local, collect or credit card. Ask Karen Grayson which phone to use.

CLOTHING

Casual and appropriate to the time of the year in Michigan, where it can get below zero in the winter, and the 90's in July and August. Shop coats are provided during laboratory sessions.

TRANSPORTATION

Provision for transportation to Detroit Metropolitan Airport on the final Friday via a regular limousine service can be arranged by the school staff.

CLASS HOURS

8:15 a.m. to 4:30 p.m. (3:30 p.m. final Friday)

SMOKING

Smoking is allowed throughout the school except in the classroom.

COFFEE AND SMOKE BREAKS

There are periodic coffee and smoke breaks during the day. Each day there are complimentary doughnuts.

MEDICAL

Vickers Medical Department is located in Vickers World Headquarters across the street, and is open from 8:15 to 4:45 Monday through Friday. More extensive medical and dental facilities are available in the area. See Karen for details.

CAMERAS

O.K. on school property, but not at Vickers World Headquarters.

GENERAL INSTRUCTIONS

1. The purpose of this document is to provide a clear and concise guide for the use of the system. It is intended for use by all personnel who are responsible for the operation and maintenance of the system.

2. The system is designed to be used in a safe and efficient manner. It is important to follow the instructions carefully to avoid any accidents or damage to the system.

3. The system is a complex piece of equipment and it is important to understand its capabilities and limitations. It is recommended that users receive training before operating the system.

4. The system is designed to be used in a variety of environments. It is important to ensure that the system is used in a safe and secure manner.

5. The system is a valuable asset and it is important to take steps to protect it. This includes ensuring that the system is kept up to date and that it is protected from unauthorized access.

6. The system is designed to be used in a safe and efficient manner. It is important to follow the instructions carefully to avoid any accidents or damage to the system.

7. The system is a complex piece of equipment and it is important to understand its capabilities and limitations. It is recommended that users receive training before operating the system.

8. The system is designed to be used in a variety of environments. It is important to ensure that the system is used in a safe and secure manner.

9. The system is a valuable asset and it is important to take steps to protect it. This includes ensuring that the system is kept up to date and that it is protected from unauthorized access.

10. The system is designed to be used in a safe and efficient manner. It is important to follow the instructions carefully to avoid any accidents or damage to the system.

TWO-WEEK MOBILE HYDRAULICS PROGRAM M-201THEORY AND SHOP PRACTICE

REFERENCES: Vickers Mobile Hydraulics Manual M-2990-A
Class and Laboratory Workbooks

FIRST WEEKMONDAY

- A. Introduction
 - 1. Objectives of course
 - 2. How accomplished
 - 3. Materials for study
- B. Quiz - Pre-Course
- C. Basic hydraulic principles
 - 1. Pascal's Law
 - 2. Force, pressure and area relationships
 - 3. Force multiplication
 - 4. How accomplished
 - 5. Speed of operation
 - 6. Concept of work
 - 7. Concept of power
 - 8. Pump cavitation and aeration demonstration
- D. Fluids and reservoirs
 - 1. Fluid properties
 - 2. Reserve sizing
- E. Homework assignment, CTS-175

TUESDAY

- A. Homework review, CTS-175
- B. Contamination control, filtration and prevention of leakage
 - 1. Filter selection
 - a. Beta ratios and efficiencies
 - 2. Leakage control
- C. Elementary quiz
- D. Quiz review

TUESDAY (CONTINUED)

- E. Pumps - vane and gear
 - 1. Pumps - general
 - a. Positive displacement
 - b. Non-positive displacement
 - 2. Pumps - gear
 - a. Construction
 - b. Operating characteristics
 - c. Inlet requirements
 - d. Mounting and shaft considerations
 - e. Graphical representation
 - 3. Vane - square pump, VQ intra-vane pump
 - a. Construction, assembly, adjustments
 - b. Operating characteristics
 - c. Inlet requirements
 - d. Mounting and shaft considerations
 - e. Possible malfunction areas and remedies
 - f. Graphical representation
- F. Homework assignment, CTS-51

WEDNESDAY

- A. Homework review, CTS-51
- B. Vane pumps (continued)
- C. Workshop - vane pumps
 - 1. Disassembly, assembly and test
- D. Vane motors
 - 1. Operation
 - 2. Construction
 - 3. Application
 - 4. Graphical representation
- E. Quiz - Vane and Gear Pumps
- F. Quiz review

WEDNESDAY (CONTINUED)

- F. Relief valves
 - 1. Simple relief valve
 - a. Function
 - b. Construction
 - c. Operating characteristics
 - d. Graphical representation
 - 2. Compound type relief valve
 - a. Function
 - b. Construction
 - c. Operating characteristics
- G. Flow controls
 - 1. Applied to power steering pumps
 - a. Operation
 - b. Construction - combined with relief valve
- H. Homework assignment, CTS-123

THURSDAY

- A. Review homework, CTS-123
- B. Flow controls (continued)
- C. Directional control valves
 - 1. Poppet type
 - a. Check
 - b. Pilot operated
 - c. Construction
 - d. Function
 - e. Operating characteristics
 - f. Graphical representation
 - 2. Sliding spool valves
 - a. Four-way
 - b. Function
 - c. Multiple unit construction
 - d. Operating characteristics
 - e. Center conditions
 - f. Graphical representation
 - g. Problem areas - misapplication
- D. Workshop - directional controls
 - 1. Disassembly and assembly
 - a. CM11 multiple unit directional valves

THURSDAY (CONTINUED)

- E. Quiz
 - 1. Pressure Controls
 - 2. Flow Controls
 - 3. Directional Controls
- F. Homework assignment - CTS-4

FRIDAY

- A. Homework review, CTS-4
- B. Quiz review
- C. Piston pumps
 - 1. In-line design - B series
 - 2. Bent axis design
 - 3. Radial design
 - 4. Construction and operation
 - 5. Controls
- D. Pressure reducing valves
 - 1. Application
 - 2. Construction
 - 3. Operation
 - 4. Graphical representation
- E. Workshop
 - 1. In-line piston pumps - B series
 - a. Disassembly and reassembly
 - 2. Pressure reducing valve
 - a. Fluid Power Trainer exercise, CTS-149
- F. Circuits
 - 1. Counterbalance valve application
 - 2. Brake valve application
 - 3. Priority valve application
- G. Quiz - first week's material
- H. Quiz review



1. Hydraulics is a means of transmitting power. It may be used to multiply force or modify motions.
2. PASCAL'S LAW: Pressure exerted on a confined fluid is transmitted undiminished in all directions and acts with equal force on all equal areas and at right angles to them.
3. To find the area of a piston (circle), square the diameter and multiply by .7854. $A = D^2 \times .7854$.
4. The force (pounds) exerted by a piston can be determined by multiplying the piston area (square inches) by the pressure applied (PSI). $F = P \times A$
5. To determine the volume of liquid (cubic inches) required to move a piston a given distance, multiply the piston area (sq. inches) by the stroke required (inches). $Vol. = A \times L$
231 cubic inches = One U.S. Gallon
6. Work is force acting through a distance. $WORK = FORCE \times DISTANCE$.
Example: Work (in. lbs.) = Force (lbs.) $\times$ Distance (in.)
7. Power is the rate of doing work. $Power = \frac{Work}{Time} = \frac{Force \times Distance}{Time}$
8. Hydraulic oil serves as a lubricant and is practically non-compressible. It will compress approximately 0.4 of 1% at 1000 PSI and 1.1% at 3000 PSI at 120°F.
9. The weight of hydraulic oil may vary with a change in viscosity. However, 55 to 58 lbs. per cubic foot covers the viscosity range from 150 SSU to 900 SSU at 100°F.
10. Pressure at the bottom of a one foot column of oil will be approximately 0.4 PSI. To find the approximate pressure at the bottom of any column of oil, multiply the height in feet by 0.4.
11. Atmospheric pressure equals 14.7 PSIA at sea level.
12. Gauge readings do not include atmospheric pressure unless marked PSIA.
13. There must be a pressure drop (pressure difference) across an orifice or other restriction to cause flow through it. Conversely, if there is no flow, there will be no pressure drop.
14. A fluid is pushed, not drawn, into a pump.
15. A pump does not pump pressure; its purpose is to create flow. Pumps used to transmit power are usually positive displacement type.
16. Pressure is caused by resistance to flow. A pressure gauge indicates the workload at any given moment.
17. Fluids take the course of least resistance.
18. Speed of a cylinder piston is dependent upon its size (piston area) and the rate of flow into it.
 $Velocity (inches/min.) = \frac{Flow (cu. inches/min.)}{Area (sq. in.)}$ OR
 $Flow = Velocity \times Area$

19. Flow velocity through a pipe varies inversely as the square of the inside diameter. Doubling the inside diameter increases the area four times.

20. Friction losses (pressure drop) of a liquid in a pipe vary with velocity.

21. To find the actual area of a pipe needed to handle a given flow, use the formula:

$$\text{Area (sq. in.)} = \frac{\text{GPM} \times .3208}{\text{Velocity (Ft./Sec.)}} \quad \text{OR}$$

$$\text{Velocity (Ft./Sec.)} = \frac{\text{GPM}}{3.117 \times \text{Area (sq. in.)}}$$

22. The actual inside diameter of standard pipe is usually larger than the nominal size quoted. A conversion chart should be consulted when selecting pipe.

23. Steel and copper tubing size indicates the outside diameter. To find the actual inside diameter, subtract two times the wall thickness from the tube size quoted.

24. Hydraulic hose sizes are usually designated by their nominal inside diameter. With some exceptions, this is indicated by a dash number representing the number of sixteenth inch increments in their inside diameter.

25. One H.P. = 33,000 ft. lbs. per minute or 33,000 lbs. raised one foot in one minute. One H.P. = 746 watts. One H.P. = 42.4 BTU per minute.

26. To find the H.P. required for a given flow rate at a known pressure, use the formula:

$$\text{Pump Output H.P.} = \text{GPM} \times \text{PSI} \times .000583 = \frac{\text{GPM} \times \text{PSI}}{1714}$$

To find the H.P. required to drive a hydraulic pump of a given volume at a known pressure, use the formula:

$$\text{Pump Input H.P.} = \frac{\text{GPM} \times \text{PSI} \times .000583}{\text{Pump Efficiency}} = \frac{\text{GPM} \times \text{PSI}}{1714 \times \text{Pump Efficiency}}$$

If actual pump efficiency is not known, use the following rule of thumb formula for Input H.P.:

$$\text{Input H.P.} = \text{GPM} \times \text{PSI} \times .0007$$

27. The relationship between Torque and H.P. is:

$$\text{Torque (lb. in.)} = \frac{63025 \times \text{H.P.}}{\text{RPM}} \quad \text{OR}$$

$$\text{H.P.} = \frac{\text{Torque (lb. in.)} \times \text{RPM}}{63025}$$

28. To determine the pump capacity (GPM) needed to extend a cylinder piston of a given area (sq. in.) thru a given distance (inches) in a specific time (seconds):

$$\text{GPM} = \frac{\text{Piston Area (sq. in.)} \times \text{Length (inches)} \times 60 \text{ sec.}}{\text{Time (seconds)} \times 231 \text{ cu. in.}}$$

HYDRAULIC FLUID ANALYSIS

Pumps, valves, cylinders, motors, and all other hydraulic system components require clean hydraulic fluid. Using filters and changing them periodically is not enough to insure that the fluid is clean. The only way to determine fluid cleanliness is to have the fluid inspected by a qualified laboratory.

The minimum lab report for most hydraulic systems should include:

- A. Particle count by micrometer size range.
- B. Water content.
- C. Quantitative report of presence of wear elements such as aluminum, zinc, silicon, iron, lead, etc..
- D. Viscosity.

If neither your company nor your fluid supplier has a laboratory equipped to provide this service, you might find one of the following able to help you.

Although Vickers does not endorse these companies, we have used their services and found them satisfactory.

ANALYSTS, INC.
61 Suttons Lane
Piscataway NJ 08854

(201) 985-8282

ANALYSTS, INC.
12715 Royal Drive
Stafford TX 77477

(713) 494-3042

ANALYSTS, INC.
2450 Hassell Road
Hoffman Estates IL 60195

(312) 884-7877

ANALYSTS, INC.
2910 Ford Street
Oakland CA 94601

(415) 536-5914

OPTIMAL SYSTEMS, INC.
P.O. Box 1182
Atlanta GA 30301

(404) 448-5235

SPECTRO METRICS
35 Executive Park Drive N.E.
Atlanta GA 30329

(404) 321-7909





OIL RECOMMENDATIONS FOR MOBILE HYDRAULIC SYSTEMS

The oil in a hydraulic system serves as the power transmission medium. It is also the system's lubricant and coolant. Selection of the proper oil is a requirement for satisfactory system performance and life.

Recommendations presented in this data sheet will assist in the selection of suitable oils for use with Vickers products. Vickers does not publish a recommended oil list by brand name or supplier due to the extremely wide variety of oil types on the market.

In most cases, use of these recommendations will lead to selection of a suitable oil. However, due to the complex nature of oil formulation, the variety of oils available and peculiarities of individual hydraulic applications, there will be rare instances where an oil selected on the basis of these recommendations will yield unsatisfactory results. Vickers cannot be responsible for such exceptions. In this respect, the customer is encouraged to consult his Vickers representative when selecting an oil.

IMPORTANT FACTORS IN SELECTING AN OIL

ADDITIVES — Hydraulic fluids contain a number of additive agents which materially improve various characteristics of oil for hydraulic systems. These additives are selected to reduce wear, increase chemical stability, inhibit corrosion and depress the pour point.

Pump performance and reliability are directly affected by the antiwear additive formulation contained in the oil. Oils providing a high level of antiwear protection are recommended for optimum performance and long life.

VISCOSITY — Viscosity is the measure of fluidity. The oil selected must have proper viscosity to maintain an adequate lubricating film at system operating temperature.

In addition to dynamic lubricating properties, oil must have sufficient body to provide an adequate sealing effect between working parts of pumps, valves, cylinders and motors, but not enough to cause pump cavitation or sluggish valve action. Optimum operating viscosity of the oil should be between 16 cSt (80 SUS) and 40 cSt (180 SUS).

"Viscosity index" reflects the way viscosity changes with temperature. The smaller the viscosity change, the higher the viscosity index. The viscosity index of hydraulic system oil should not be less than 90. Multiple viscosity oils, such as SAE 10W-30, incorporate additives to improve viscosity index (polymer thickened). Oils of this type generally exhibit both a temporary and permanent decrease in viscosity due to oil shear encountered in the operating hydraulic system. The actual viscosity can, therefore, be far less in the operating hydraulic system than what is shown in normal oil data. Accordingly, when such oils are selected, it is necessary to use those with high shear stability to insure that viscosity remains within recommended limits while in service.

CHEMICAL STABILITY — Oxidative and thermal stability are essential characteristics of oils for Mobile hydraulic systems. The combination of base stocks and additives should be stable during the expected lifetime of the oil when exposed to the environment of these systems.

SUITABLE TYPES OF OIL

CRANKCASE OIL having letter designation SC, SD, SE or SF per SAE J183 FEB80. Note that one oil may meet one or more of these designations.

ANTIWEAR HYDRAULIC OIL — These are produced by all major oil suppliers and should consist of good quality base stocks compounded with antiwear, antioxidation, and antirust additives.

Due to the large number of different antiwear hydraulic oils, it is impossible for Vickers to test its products with all of them and recommend those that are suitable. Because of this, an evaluation procedure was developed for fluid suppliers to establish the suitability of their products for use in Vickers components. Publication M-2952-S, "Pump Test Procedure for Evaluation of Antiwear Hydraulic Fluids for Mobile Systems," which gives the details of this test procedure, is available on request.

CERTAIN OTHER TYPES OF PETROLEUM OIL are suitable if they meet the following provisions:

1. Contain the type and content of antiwear additives found in the above designated crankcase oils, and have passed the pump tests as given in M-2952-S.
2. Have sufficient chemical stability for Mobile hydraulic system service.
3. Meet the viscosity recommendations shown in the following tables.

OIL VISCOSITY RECOMMENDATIONS

CRANKCASE OILS

Hydraulic System Operating Temperature Range*	SAE Viscosity Designation
-23°C to 54°C (-10°F to 130°F)	5W, 5W-20, 5W-30
-18°C to 83°C (0°F to 180°F)	10W
-18°C to 99°C (0°F to 210°F)	10W-30, 10W-40
10°C to 99°C (50°F to 210°F)	20-20W

ANTIWEAR HYDRAULIC OILS

Hydraulic System Operating Temperature Range*	ISO Viscosity Grade
-21°C to 60°C (- 5°F to 140°F)	22
-15°C to 77°C (5°F to 170°F)	32
- 9°C to 88°C (15°F to 190°F)	46
- 1°C to 99°C (30°F to 210°F)	68

*Temperatures shown are cold (ambient) start-up to maximum operating. During cold start-up, avoid high-speed operation of hydraulic components until the system is warmed up to provide adequate lubrication.

ARCTIC CONDITIONS represent a specialized field where extensive use is made of heating equipment before starting. If necessary, this and judicious use of the following recommendations should be used:

1. SAE 5W or 5W-20 oil.
2. Oils specially developed for use in arctic conditions, such as synthetic hydrocarbons, esters, or mixtures of the two.

Operating temperature should be closely monitored to avoid exceeding a temperature of 54°C (130°F) with any lightweight oil.

SPECIAL REQUIREMENTS

When special considerations indicate a need to depart from recommended oils or operating conditions, consult your Vickers representative.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean:

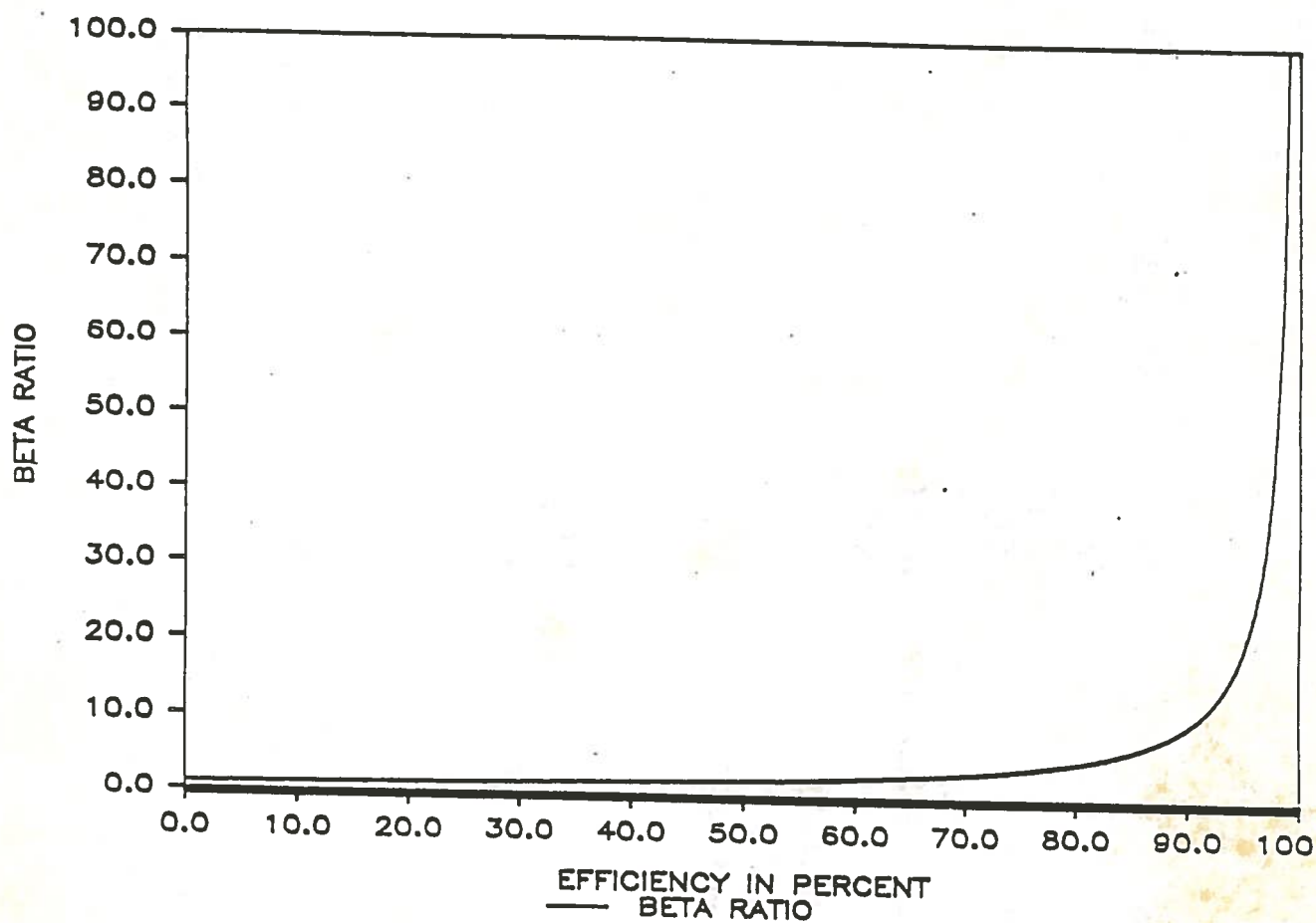
1. Clean (flush) entire system to remove paint, metal chips, welding shot, etc.

2. Filter each change of oil to prevent introduction of contaminant into the system.
3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.
4. Provide continuous protection of the system from entry of airborne contamination by sealing the system and/or by proper filtration of the air.
5. Maintain the proper oil level and regularly service filters, breathers and reservoirs. The importance of these precautions cannot be overemphasized.
6. Use good system and reservoir design and control fluid temperature to insure minimum oil aeration.
7. Take precautions to prevent moisture contamination. Change fluid whenever contamination occurs because even small amounts of water can have a substantial effect on system performance, as well as induce corrosion and oil breakdown.

VICKERS

VICKERS, INCORPORATED
1401 Crooks Road - Troy, Michigan 48064

BETA RATIO VERSUS EFFICIENCY



GRAPH 4

CTS-275

2 OF 4

VICKERS PRODUCTS

ISO CLEANLINESS CODE REQUIRED OLD "SAE CLASS CODE"

Vane Products

18/15

6

Piston Products

16/13

4

All except PVA120

16/12

Pressure Controls

18/15

6

Proportional Pressure Controls

16/13

4

Flow Controls

18/15

6

Proportional Flow Controls

16/13

4

Directional Controls

18/15

6

Proportional Directional Ctls.

16/13

4

Servo Valves

15/11

2-3

Hydraulic Motors

Piston

16/13

4

Vane

18/15

6

HMA

18/15

6

Gear Products

16/13

4

To obtain acceptable, long service life of these products when used in industrial applications, provide full flow filtration using filters selected from Vickers series OFF, OFR and OFRS.

Consult your Vickers sales representative for recommended ISO cleanliness codes when these products are used in mobile applications.

VICKERS FILTER FACT SHEET

Typical Model Code	Nominal Micronic Rating	Rated Flow (GPM)	Maximum Pressure (PSI)	Beta 10 Ratio	Dirt Holding Capacity ACFTD (Grams)	Press.drop Drop at Rated Flow Clean Elem. (PSI)	Standard By-pass Pressure (PSI)	Replacement Element Kit Number
OFP-15-S-10	10	15	3000	5	2.25	15	40	926412
OFP-15-S-3M-10	3	15	3000	75	1.5	29	40	926410
OFP-35-S-10	10	35	3000	5	5.6	25	40	926416
OFP-35-S-3M-10	3	35	3000	75	2.3	35	40	926414
OFR-15-S-10	10	15	600	1.5	9.5	3	25	941447
OFR-15-S-3M-10	3	15	600	20	5.5	8	25	941445
OFR-30-S-10	10	30	600	1.5	20	8	25	941448
OFR-30-S-3M-10	3	30	600	20	9	13	25	941446
OFR-60-S-10	10	60	400	1.5	47	3	24	941411
OFR-60-S-3M-10	3	60	400	20	33	6	24	941409
OFR-120-S-10	10	120	400	1.5	100	7.5	24	941412
OFR-120-S-3M-10	3	120	400	20	65	13	24	941410
OFRS-15-S-10	10	15	100	2	17	7	25	573082
OFRS-15-S-25M-10	25	15	100	DNA	24 (coarse dust)	4	25	573083
OFRS-25-S-10	10	25	100	2	17	13	25	573082

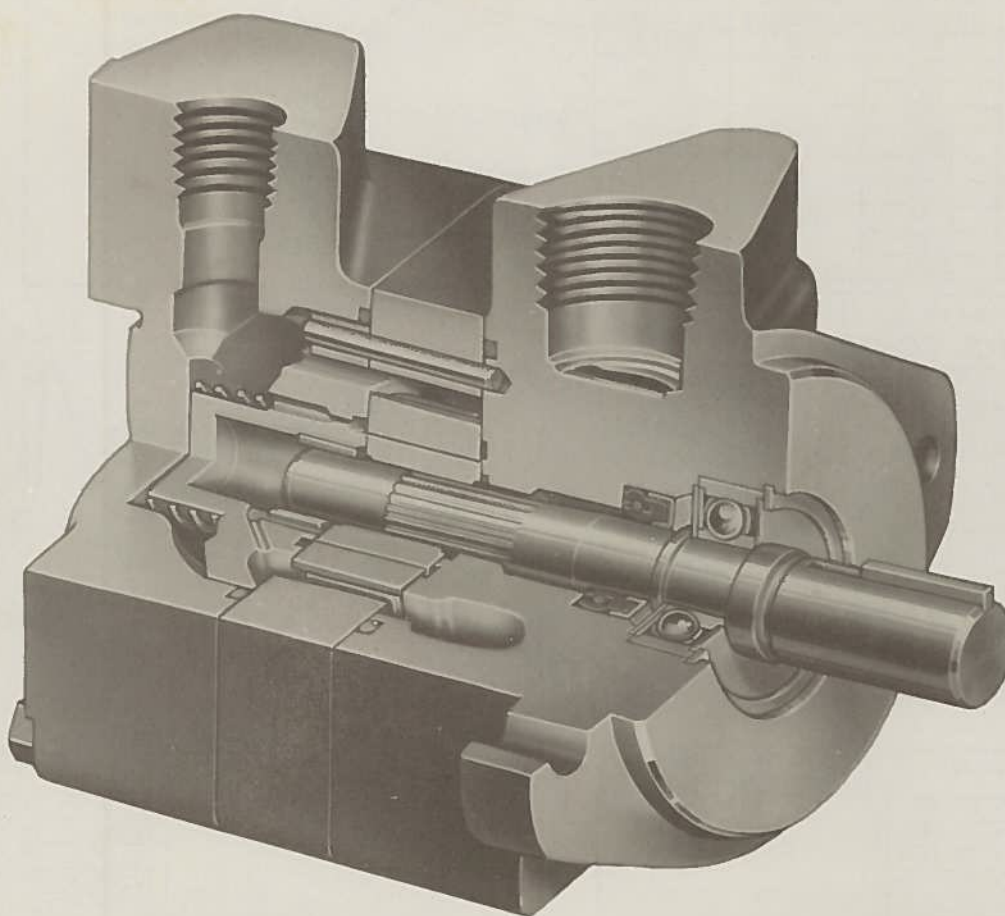
VICKERS FILTER FACT SHEET

Typical Model Code	Nominal Micronic Rating	Rated Flow (GPM)	Maximum Pressure (PSI)	Beta 10 Ratio	Dirt Holding Capacity ACFTD (Grams)	Press.drop Drop at Rated Flow Clean Elem. (PSI)	Standard By-pass Pressure (PSI)	Replacement Element Kit Number
OFRS-25-S-25M-10	25	25	100	DNA	24 (coarse dust)	7.5	25	573083
OFRS-60-S-10	10	60	100	3	24	11	25	941107
OFRS-60-S-10-S14	10	60	100	3	49	8	25	926388
OFRS-60-S-3M-10	3	60	100	20	17	18	25	941190
OFRS-60-S-25M-10	25	60	100	DNA	40 (coarse dust)	8	25	941191

Service Parts Information

**Vane
Pumps**

V20, V20F-11 Design
V20P-11/12 Design



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 9-1-85

M-2004-S

V20P - **** - **** - 11/12 PRIORITY VALVE COVER

DESIGN	PLUG	SPRING	PISTON
-11	7077	256961	257063
-12	433026	433025	433024

MODEL	SCREW (4 REQ'D) TORQUE TO 80±5 lb. ft.
V20P-**-6*-****11/12	11165
V20P-**-7*-****11/12	
V20P-**-8*-****11/12	9431
V20P-**-9*-****11/12	
V20P-**-10*-****11/12	
V20P-**-11*-****11/12	96168
V20P-**-12*-****11/12	
V20P-**-13*-****11/12	

MODEL	PRESSURE SETTING	SPRING -11 DESIGN	SPRING -12 DESIGN
V20P-****-***A1*	250	252886	252886
V20P-****-***B1*	500	2280	2280
V20P-****-***C1*	750		
V20P-****-***D1*	1000	2282	435626
V20P-****-***E1*	1250		
V20P-****-***F1*	1500		
V20P-****-***G1*	1750		
V20P-****-***H1*	2000	2281	2281
V20P-****-***J1*	2250		
V20P-****-***K1*	2500		

V20F - **** - **** - 11 FLOW CONTROL COVER

MODEL DESIGNATION	PRESSURE SETTING (P. S. I.)	CONTROL VALVE SUB-ASSEMBLY
V20F-****-***A11	250	229613
V20F-****-***B11	500	233018
V20F-****-***C11	750	232794
V20F-****-***D11	1000	232795
V20F-****-***E11	1250	232796
V20F-****-***F11	1500	232797
V20F-****-***G11	1750	232798
V20F-****-***H11	2000	232799
V20F-****-***J11	2250	233019
V20F-****-***K11	2500	233020

MODEL	SCREW (4 REQ'D) TORQUE TO 80±5 lb. ft.
V20F-**-6*-****11	11165
V20F-**-7*-****11	
V20F-**-8*-****11	9431
V20F-**-9*-****11	
V20F-**-10*-****11	
V20F-**-11*-****11	96168
V20F-**-12*-****11	
V20F-**-13*-****11	

COVER	MODEL
316090	V20F-***P-***2*-11
306313	V20F-***S-***2*-11
306314	V20F-***T-***2*-11

MODEL	SCREW (4 REQ'D) TORQUE TO 8 lb. ft.
V20*-**-6*-****11/12	131485
V20*-**-7*-****11/12	
V20*-**-8*-****11/12	
V20*-**-9*-****11/12	131486
V20*-**-10*-****11/12	
V20*-**-11*-****11/12	
V20*-**-12*-****11/12	1319
V20*-**-13*-****11/12	

MODEL DE
V20*-****
V20*-****
V20*-****
V20*-****
V20*-****
V20*-****

F
SE

COVER	MODEL
280690	V20-****F-***
375468	V20-***K-***
313657	V20-***P-***
281145	V20-***R-***
293373	V20-***S-***
291045	V20-***Y-***

359287 PRESSUR
(INCLUDES 2802

28422 SPRIN

OPTION	▲SEAL KIT	▲"O" RING (2 REQ'D) SERVICED IN SEAL KIT	▲SEAL	RETAINING RING	BEARING	SHAFT	KEY	NUT	RETAINING RING	SHAFT TYPE
11/12	922733	154090	229235	98653	98574	280372	5881		109975	STRAIGHT
11/12						280504	1615	132260		THREADED
11/12						297330	1609	—		KEYED-STUB
11/12						280515	—	—		SPLINED
11/12						294922	—	—		SPLINED
11/12						328096	—	—		SPLINED

VALENT
919805

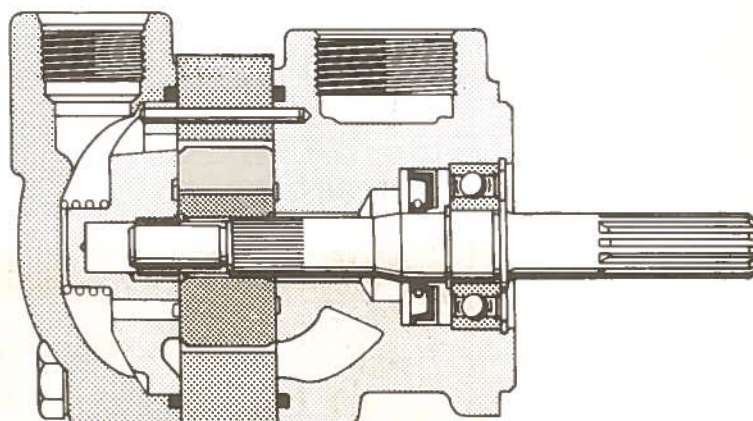
VE S/A
HING)

267
HING

FOOT BRACKET MOUNTING
KIT FB-A-10 INCLUDES:
177939 SCREW (2 REQ'D)

MODEL	BODY		
	V20*-1*	V20*-4*	V20*-6*
V20*-E	345486	—	324045
V20*-F	297228	—	—
V20*-P	280689	308628	396975
V20*-R	313409	—	—
V20*-S	294266	—	295716

NG	ROTOR	VANE KIT (12 VANES)	▲"O" RING (2 REQ'D)	CARTRIDGE KIT	PIN (2 REQ'D)
SERVICED IN CARTRIDGE KIT					
150	358328	923485	154090	923480	2161
152				923481	
791	358330	923493		923483	2478
789				923484	
309	358332	923478		923620	16662
156				923482	
806	358334	923479		923486	9603
807				923487	



MODEL CODE BREAKDOWN

V 20 (P) * * * * - * * (*) (*) 11/12 - * * * L

VANE PUMP
(STRAIGHT VANE)

SERIES

F - FLOW CONTROL COVER
P - PRIORITY VALVE COVER
OMITTED-STANDARD COVER

MOUNTING

- 1 - 2 BOLT FLANGE (SAE "A" SIZE)
- 2 - FOOT BRACKET AT 12 O'CLOCK
(VIEWED FROM SHAFT END)
- 3 - POWER TAKE-OFF
- 4 - FACE TYPE
- 6 - "B" MOUNTING FLANGE
- 23 - FOOT BRACKET AT 3 O'CLOCK
- 26 - FOOT BRACKET AT 6 O'CLOCK
- 29 - FOOT BRACKET AT 9 O'CLOCK

INLET PORT CONNECTIONS

- E - 1.5 INCH DIA.
2 BOLT FLANGE
- F - 1.156 INCH DIA.
2 BOLT FLANGE
- P - 1.25 N.P.T.F.
- R - 1.00 N.P.T.F.
- S - 1.625 - 12 UN 2B THD.

RING CAPACITY USGPM

- 1200 RPM-100 PSI
- 6 - 6 9 - 9 12 - 12
- 7 - 7 10 - 10 13 - 13
- 8 - 8 11 - 11

FOR LEFT HAND ROTATION
VIEWED FROM SHAFT END
(OMIT FOR RIGHT HAND
ROTATION)

SPECIAL FEATURE SUFFIX

V20, V20F - 11 DESIGN
V20P - 12 DESIGN

PRESSURE SETTING

- A - 250 PSI F - 1500 PSI
- B - 500 PSI G - 1750 PSI
- C - 750 PSI H - 2000 PSI
- D - 1000 PSI J - 2250 PSI
- E - 1250 PSI K - 2500 PSI

FLOW RATE THROUGH ORIFICE
IN COVER IN USGPM
2 - 2 USGPM

PRESSURE PORT POSITIONS
VIEWED FROM COVER END

- A - OPPOSITE INLET CONNECTION
- B - 90° COUNTERCLOCKWISE FROM
INLET CONNECTION.
- C - INLINE WITH INLET
- D - 90° CLOCKWISE FROM INLET
CONNECTION

SHAFTS

- 1 - STRAIGHT - KEYED
- 3 - THREADED
- 6 - STR. STUB-KEYED
- 11 - SPLINE
- 15 - SPLINE
- 38 - SPLINE

OUTLET PORT CONNECTIONS

CODE	STANDARD COVER	FLOW CONTROL COVER		PRIORITY VALVE COVER		
		PRESSURE	TANK	PRIMARY OUTLET	SECONDARY OUTLET	TANK
F	.687 DIA.	—	—	—	—	—
P	.750 NPT THD.	.750-16 ST. THD.	.500 NPT THD.			
S	1.062-12 ST. THD.	.750-16 ST. THD.	1.062-12 ST. THD.			
T	—	.750-16 ST. THD.	.750-16 ST. THD.	.750-16 ST. THD.	.875-14 ST. THD.	.750-16 ST. THD.

For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U.S.A.

-LABORATORY WORK SHEET-

V-20 SQUARE PUMPS

Name _____

 I. PRELIMINARY OBSERVATION

- A. What is model number of unit? _____
- B. What reference point is used to determine direction of rotation? _____

- C. What rotation is indicated on the ring? L.H.____ R.H.____
- D. What type mounting flange is used, if any?
Foot____ Flange____ None____
- E. What is size of inlet port?____ Outlet port?____
- F. How is internal leakage or slippage disposed of?____

- G. What flow rating is indicated on pump ring? _____ GPM.

 II. DISASSEMBLY

- A. Remove mounting flange or foot bracket, if used, cover and "O" ring seal.
 1. Were both locating pins for ring and pressure plate in place? Yes____ No____
 2. Was pressure plate pre-loaded spring located on pressure plate boss? Yes____ No____
- B. Remove pressure plate.
 1. Does the radius on the vane tips face the inside of the ring? Yes____ No____
 2. What is purpose of holes through the rotor at the bottom of the vane slot? _____

Note: The notch in the vane slots of the rotor were put in the rotor to facilitate manufacturing. However, they do also provide lubrication, making it easier to throw out the vanes.

C. Remove ring, rotor, vanes, and locating pins.

1. What is the purpose of the shallow circular groove in the body? _____

D. Turn pump body over and remove snap ring which retains outer bearing.

E. Tap splined end of shaft with soft hammer to force shaft out of body. (Do not remove shaft seal.)

Note: If you were servicing this unit, the condition of all parts should be inspected to determine if repair or replacement is necessary. Points to check would be:

1. Wearing surfaces of the body, pressure plate, ring and rotor for scoring and excessive wear.
2. Inspect the vanes for burrs, wear and excessive play in rotor slots.
3. Check the bearings for wear and looseness.
4. Inspect the oil seal mating surface on the shaft for scoring or wear.

III. CHECK DISASSEMBLY WITH INSTRUCTOR

IV. REASSEMBLY (Make rotation opposite that of I. C.)

- A. Slide the drive shaft into the body until the bearing is seated. Tap lightly on outer bearing race if necessary.
- B. Install snap ring.
- C. Insert "O" rings in body and cover.
- D. Insert the locating pins in the body and assembly ring for proper rotation.
- E. Place rotor on the shaft and insert the vanes in the rotor slots. Be certain that radius edge of each vane is toward ring.
- F. Place pressure plate on locating pins and flat against the ring.
- G. Place spring on pressure plate boss.
- H. Carefully place cover on pump with outlet port in desired position.

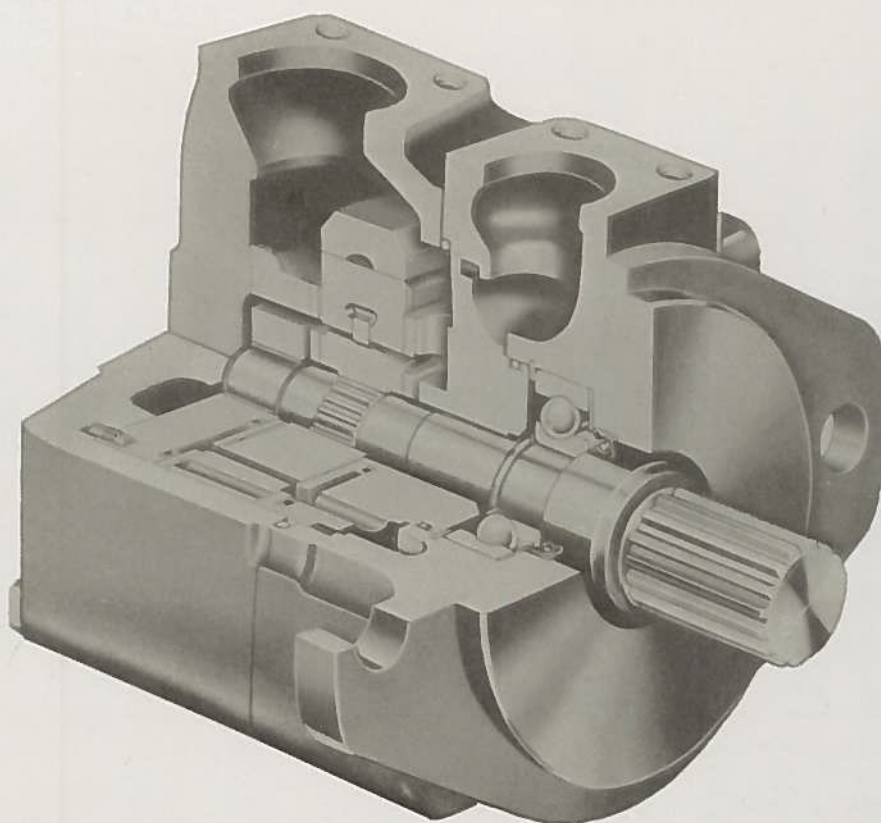
VICKERS

Overhaul Manual

41

**Single
Pumps**

25VQ, 26VQ, 30VQ, 31VQ,
35VQ and 45VQ



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 11-1-85

I-3144-S

A Libbey-Owens-Ford Company

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SECTION I - INTRODUCTION

A. PURPOSE OF MANUAL

This manual is to assist users of Vickers High Performance VQ, single pumps in properly installing, maintaining and repairing their units. The single pumps are described in detail.

Their theory of operation is discussed and instructions for installation, maintenance and overhaul are presented.

The general series of models covered are 25VQ, 26VQ, 30VQ, 31VQ, 35VQ, and 45VQ. The information given applies to the -20 design series listed in Table 1.

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts and installation drawings listed in Table 2 are available from any Vickers application engineering office or from:

Vickers, Incorporated
1401 Crooks Road
Troy, Michigan 48084

MODEL CODE BREAKDOWN

35 VQ ** A * -86 * 20 (L)

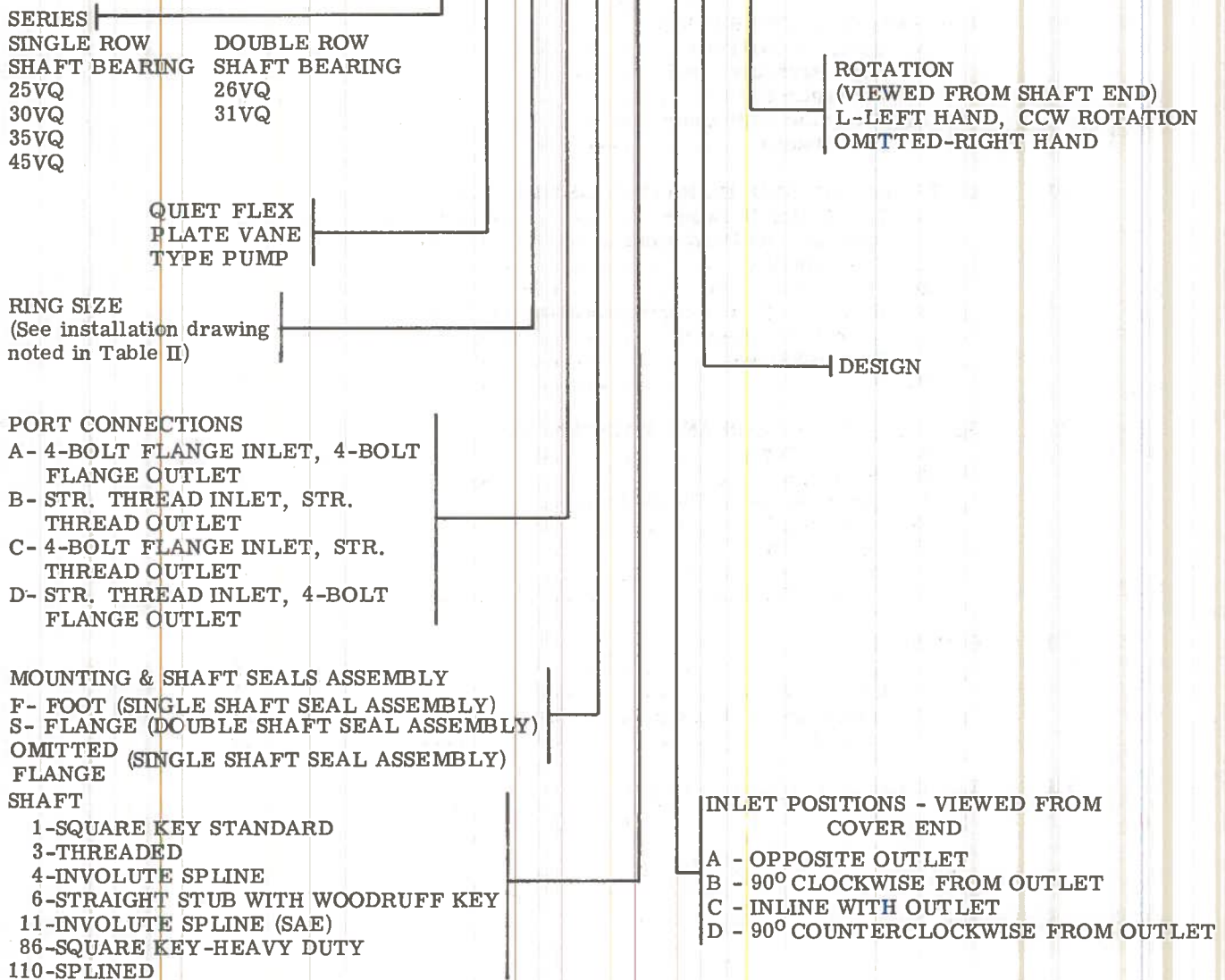


TABLE 1.

2. Model Codes - Variations within each basic model series are covered in the model code. Table 1 is a complete breakdown of the codes covering these units. Service inquiries should always include the complete unit model code number as stamped on the pump cover.

MODEL SERIES	PARTS DRAWING	INSTALLATION DRAWING
25VQ, 26VQ 30VQ, 31VQ	I-3165-S	MB-53E
35VQ	I-3167-S	
45VQ	I-3168-S	

Table 2 - Available parts and installation drawings

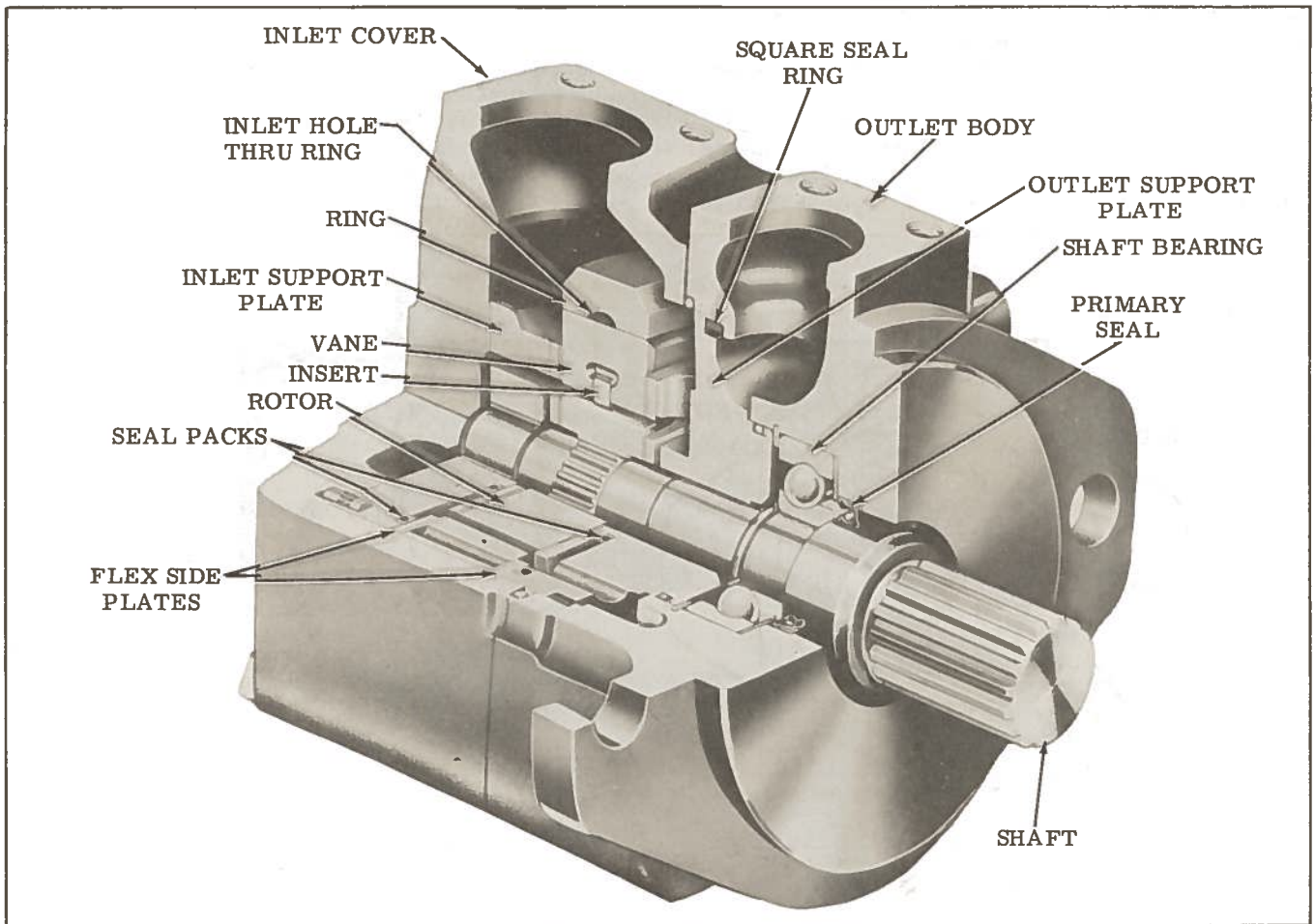


Figure 1 - Cutaway View of Typical High Performance VQ, Single Pump

SECTION II - DESCRIPTION

A. GENERAL

Pumps in this series are used to develop hydraulic fluid flow for the operation of Industrial and Mobile equipment. The positive displacement pumping cartridges are of the rotary vane type with shaft side loads hydraulically balanced. The flow rate depends on the pump size and the speed at which it is driven.

All units are designed so that the direction of rotation, pumping capacity and port positions can be readily changed to suit particular applications.

B. ASSEMBLY AND CONSTRUCTION

1. Basic Pumps - The pump illustrated in Figure 1 is representative of all single pumps in this series. The unit consist principally of an inlet cover, outlet body, driveshaft and pumping cartridge. The princi-

ple components of the cartridge are an elliptical cam ring, a slotted rotor splined to the driveshaft, an inlet and outlet support plate fitted with four special seal packs, two flex side plates, and ten vanes and inserts fitted to the rotor slots. Fluid enters the cartridge through the inlet port in the cover and is discharged through the outlet flex side plate and support plate to the outlet port in the body.

C. APPLICATION

Pump ratings in GPM, as shown in the model coding, are at 1200 RPM and 100 PSI. For ratings at other speeds and pressures, methods of installation or other application information, refer to the applicable sales installation drawing or consult a Vickers application engineer.

SECTION III - PRINCIPLES OF OPERATION

A. PUMPING CARTRIDGE

As mentioned in Section II, fluid flow is developed in the pumping cartridge. The action of the cartridge is illustrated in Figure 2. The rotor is driven within the ring by the driveshaft, which is coupled to a power source. As the rotor turns, centrifugal force on the vanes, aided by under-vane pressure fed from the outlet port, causes the vanes to follow the elliptical inner surface of the ring.

Radial movement of the vanes and turning of the rotor causes the chamber volume between the vanes to increase as the vanes pass the inlet sections of the ring. This results in a low pressure condition which

allows atmospheric pressure to force fluid into the chambers.

An additional inlet fluid path exists through a drilled hole in the cam ring. This hole connects the inlet port directly to the inlet areas of the cam ring and provides an additional flow path for fluid to get into the cartridge. (See figure 1.)

Fluid is trapped between the vanes and carried past a sealing land to the outlet section of the ring. As the outlet section is approached, the chamber volume decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the ring during normal operation.

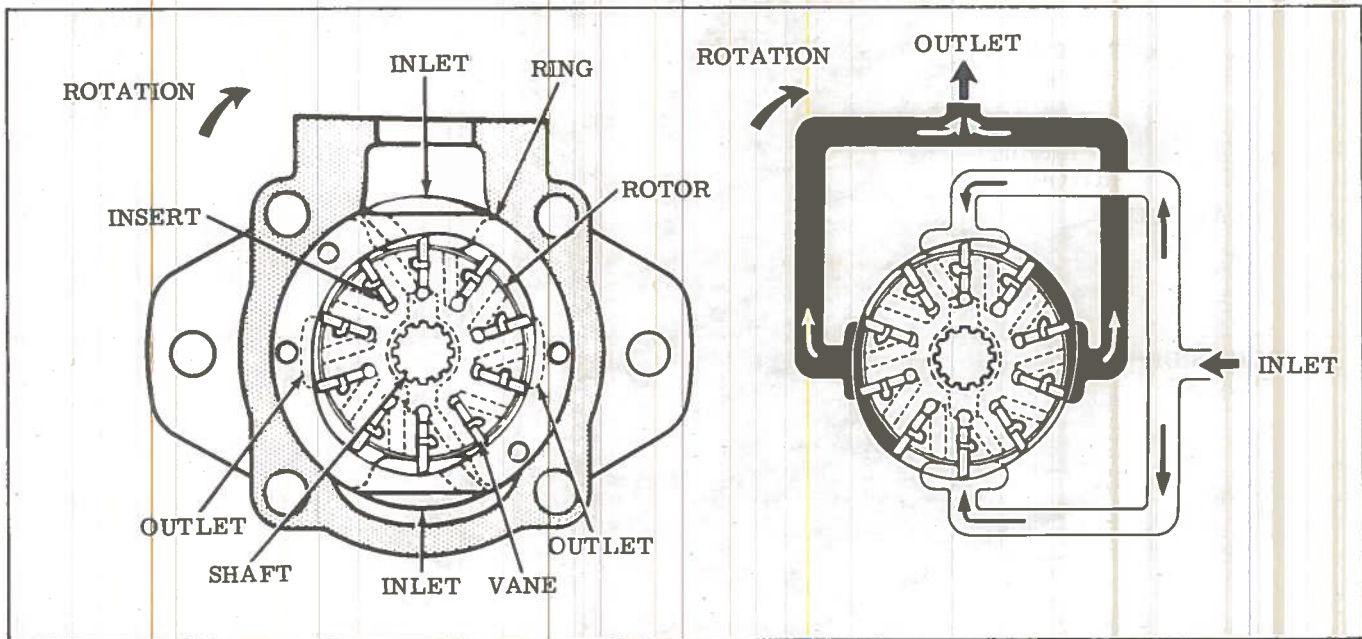


Figure 2 - Operation of Balanced, Vane-Type Cartridge.

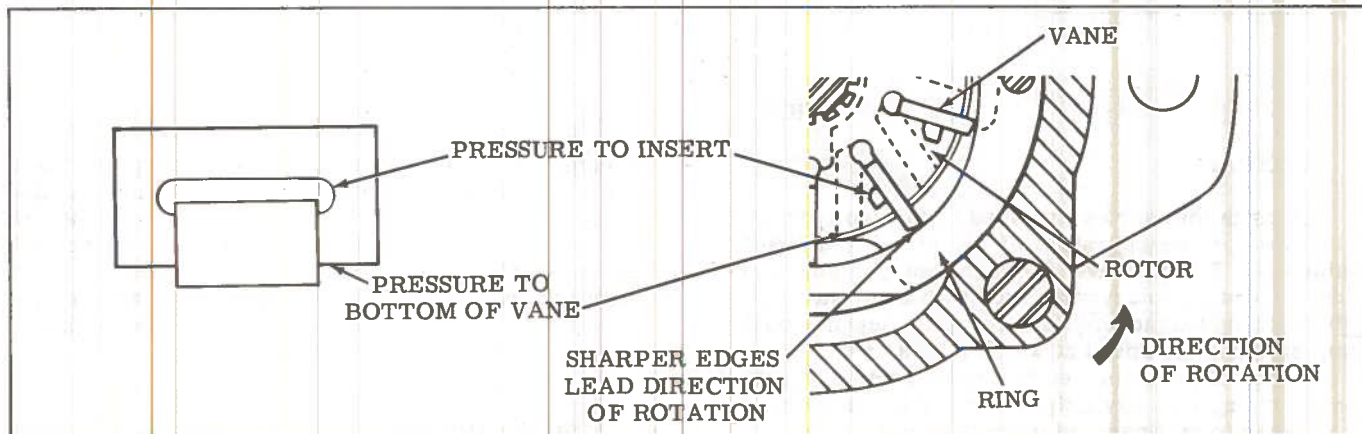


Figure 3 - Pressure Feed to Vanes in Intra-Vane Cartridge.

B. VANE PRESSURE FEED

The intra-vane design provides a means of controlling the outward thrust of the vane against the ring and maintains tip loads within reasonable limits. In the intra-vane cartridge, full system pressure is continuously applied only to the area between the vane and

insert. This area is small and thrust is correspondingly light. During vane travel through pressure areas, full system pressure is applied against the bottom area of the outer vane. The valving of pressure to and from the bottom area of the vane is through holes drilled in the rotor, as shown in Figure 3. This selective application of pressure maintains the vane in substan-

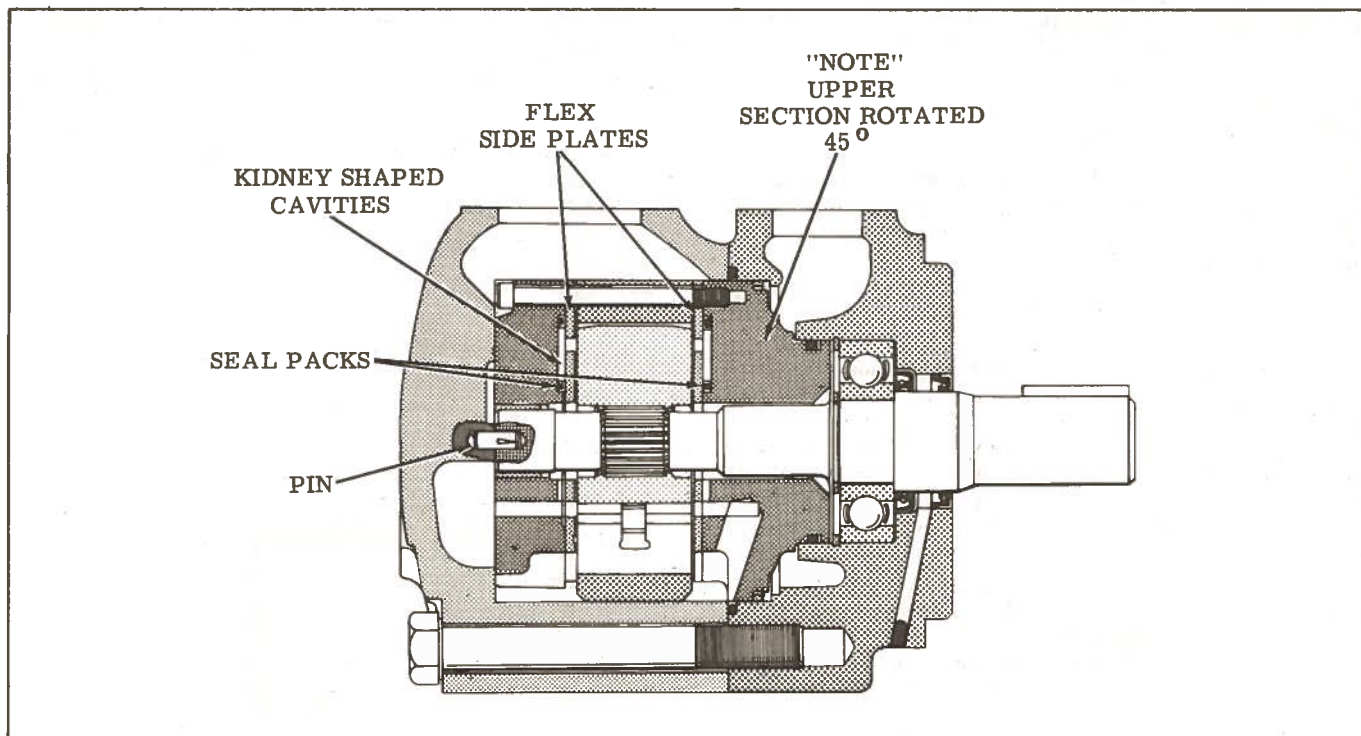


Figure 4 - Flex Side Plate Operation

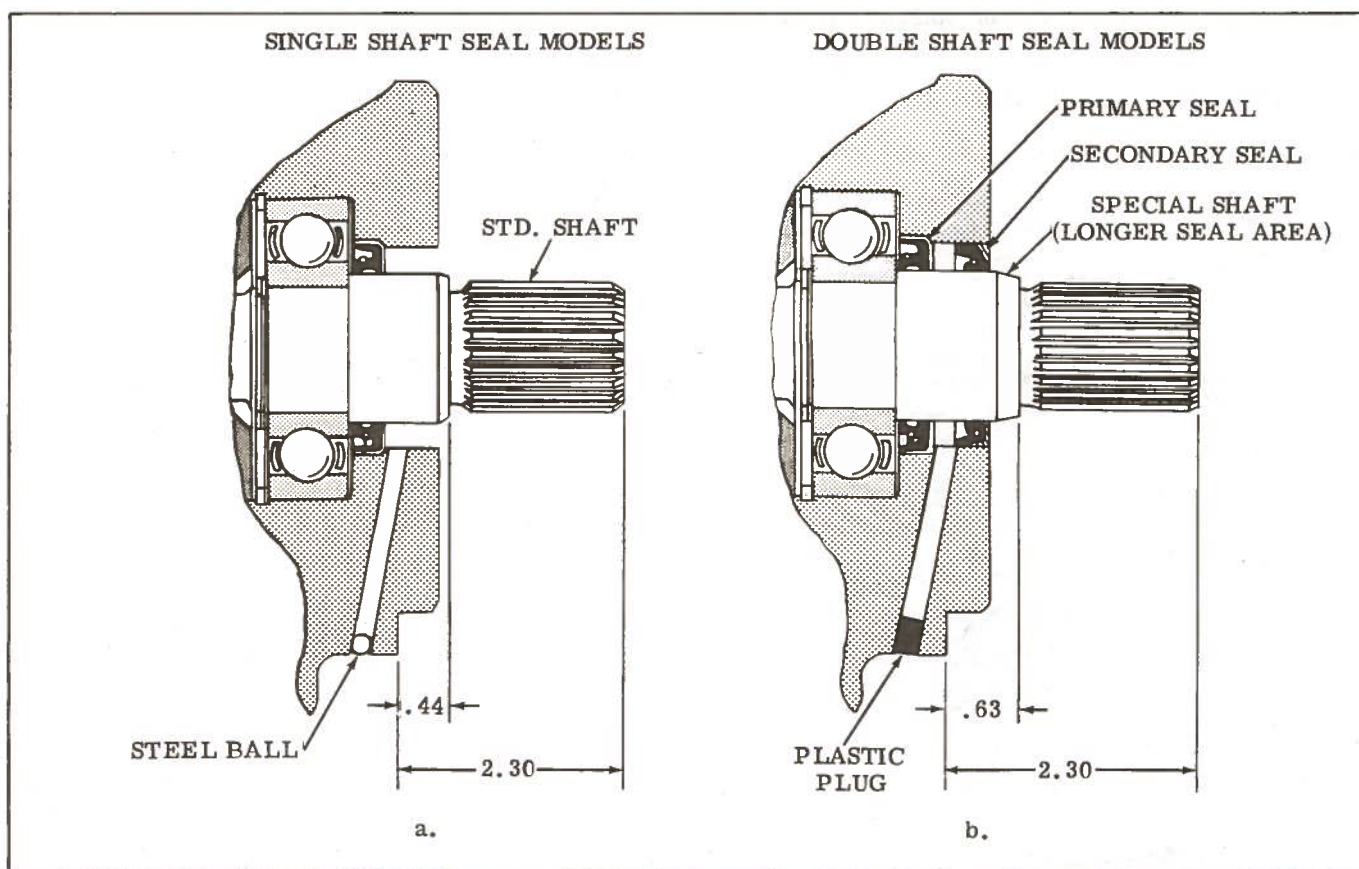


Figure 5 - Shaft Seal Arrangements

tially constant radial hydraulic balance in all positions.

Vane tip wear is compensated for automatically. As the vane wears, pressure moves the vane farther out in the rotor slot holding the vane tip against the cam ring.

C. HYDRAULIC BALANCE

The pump ring is shaped so the two pumping chambers are formed 180 degrees apart (Figure 2.) Thus, opposing hydraulic forces which develop side loads on the shaft, cancel out.

D. FLEX SIDE PLATE OPERATION

The flex side plates for both inlet and outlet are symmetrical. Pressure is fed behind each side plate into two kidney shaped cavities which are sealed by special seal packs. The two flex side plates and their associated kidney shaped cavities function in the following manner. As pressure builds up in the outlet, pressure also builds up in the cavities. The pressure in the cavities hold the flex side plates in hydrostatic balance against the rotor and provide optimum running clearances for minimum internal leakage and minimum friction. (See figure 4.)

The flex side plates also provide passages for feeding under vane pressure to the space between the vane

and insert.

The bronze faces of the flex side plates ride next to the rotor and provide excellent wear and cold start characteristics.

The inlet and outlet support plates hold the flex side plates in position and contain passages which allow fluid to pass from the inlet to the pumping cartridge and from the cartridge to the outlet port.

E. INLET BODIES

Two inlet body configurations and two shaft seal arrangements are available in this pump series. (See figure 5)

When a single shaft seal is used, a steel ball is pressed into the body. (See figure 5a.)

Double shaft seal models use a plastic plug to seal the body drain opening. This prevents external contamination from entering the area between the seals. (Refer to figure 5b.) The outer shaft seal is rated 7 PSI from an internal source and 2 PSI from an external source.

Double shaft seal models require a different shaft that may or may not be interchangeable with previous designs. This is due to an increase in shaft shoulder length to accommodate the second shaft seal. The overall shaft length of both models are the same as previous designs.

SECTION IV - INSTALLATION AND OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS

The installation drawings listed in Table 2 show correct installation dimensions and optional port locations.

B. MOUNTING AND DRIVE CONNECTIONS

Vickers high performance VQ vane pumps are designed for foot or flange mounting.

1. Direct Drive - A pilot on the pump mounting flange (Figure 6) assures correct mounting and shaft

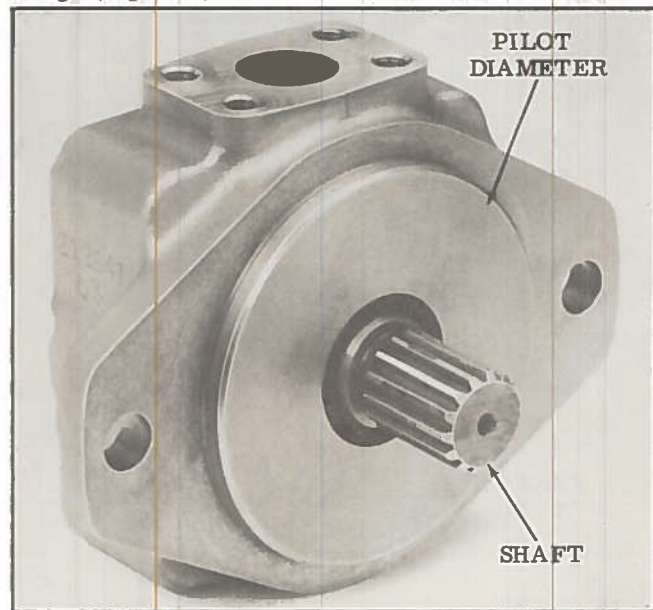


Figure 6 - Pilot Diameter

alignment, provided the pilot is firmly seated in the accessory pad of the power source. Care should be exercised in tightening all flange mounting screws to prevent misalignment.

If gaskets are used between flanges, they should be installed carefully so as to lie flat and should not be the type that will take a set. Shaft keys and couplings must be properly seated to avoid slipping and possible shearing.

Proper coupling alignment is essential to prolong pump life.

CAUTION

Pump shafts are designed to be installed in couplings with a slip fit or very light press. Pounding the coupling end on the shaft can ruin the bearings. Shaft tolerances are shown on the pump installation drawings. (See Table 2).

2. Indirect Drive - Indirect drive is not recommended for these pumps.

C. SHAFT ROTATION

NOTE

Pumps are normally assembled for right-hand (clockwise) rotation as viewed from the shaft end. A pump made for left-hand rotation is identified by an "L" in the model code. (See Table 1.)

If it is desired to reverse the direction of drive rotation, it is necessary to disassemble the pump and reverse the location of the cartridge inlet and outlet support plates. (See Section VI.)

CAUTION

Never drive a pump in the wrong direction of rotation. Seizure may result, necessitating extensive repairs.

D. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sandblasting, wire brushing and pickling.

NOTE

For instructions on pickling refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, use only as many fittings and connections as are necessary for proper installation.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

E. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components with particular emphasis on hydraulic pumps. Any oil selected for use with pumps is acceptable for use with valves or motors.

Data sheets for oil selection are available from Vickers, Inc. Technical Publications, Troy, Mi. 48084.

For Industrial Applications order data sheet I-286-S. For Mobile Applications order M-2950-S.

The oil recommendations noted in the data sheets are based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers representative.

CLEANLINESS

To insure the hydraulic system is clean:

A. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.

B. Filter each change of oil to prevent introduction of contaminants into the system.

C. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

D. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.

E. Proper oil filling and servicing of filters, breathers, reservoirs, etc., cannot be over emphasized.

sized.

F. Good system and reservoir design will insure that aeration of the oil is kept to a minimum.

SOUND LEVEL

Noise is indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at start-up temperatures can cause pump noises due to cavitation.

2. Running with a moderately high viscosity fluid will slow the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir and air will be recycled through the system.

3. Aerated fluid can also be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

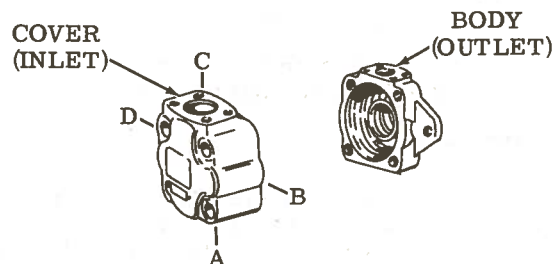
4. Contaminated fluids can cause excessive wear of internal pump parts which may result in increased sound levels.

F. OVERLOAD PROTECTION

A relief valve must be installed in the system as close to the pump outlet as possible. The relief valve limits pressure in the system to a prescribed maximum and protects the components from excessive pressure. The setting of the relief valve depends on the work requirements of the system.

G. PORT POSITIONS

The pump cover can be assembled in four positions with respect to the body. A letter in the model



MODEL	INLET COVER POSITIONS (VIEWED FROM COVER END)
VQA-*** <u>A</u> -20(L)	OPPOSITE OUTLET PORT
VQA-*** <u>B</u> -20(L)	90° CLOCKWISE FROM OUTLET
VQA-*** <u>C</u> -20(L)	IN-LINE WITH OUTLET
VQA-*** <u>D</u> -20(L)	90° COUNTERCLOCKWISE FROM OUTLET

Figure 7 - Cover Positions

code (Table 1) identifies the cover position as shown in Figure 7.

Disassembly and assembly procedures are in Section VI-B and D.

H. START-UP

Whenever it is possible to do so, fill the pump ports with system hydraulic fluid. This will make it easier for the pump to prime when it is first started.

SECTION V - SERVICE, INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

Two special tools are required to service these pumps. A driver should be used to assure installation of the primary shaft seal without damage, and a "bullet" should be placed over the end of the shaft, to avoid damaging the seal lip when the shaft is installed. Installation of the secondary seal does not require a driver. (See figure 5)

The driver can be made from tubular stock as shown in Figure 8. The tool applies a uniform pressure to the recessed area of the seal, rather than to the lip of the seal. The inside diameter of the tool will not interfere with the garter spring located around the lip of the seal.

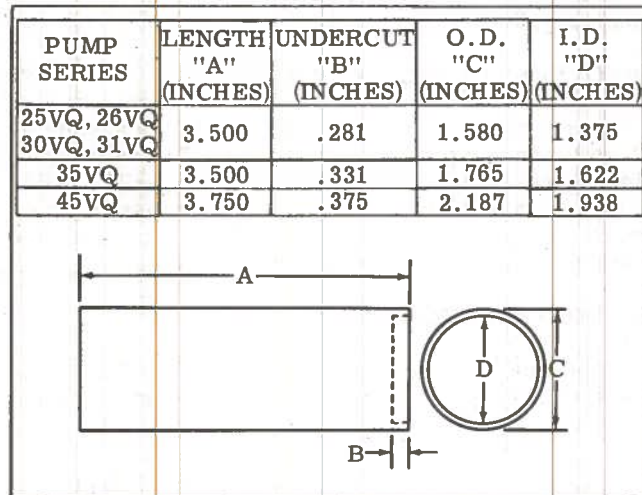


Figure 8 - Primary Shaft Seal Driver

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked

Self-Priming- With a minimum drive speed of 600 RPM, a pump should prime almost immediately. Failure to prime within a reasonable length of time may result in damage due to lack of lubrication. Inlet lines must be tight and free from air leaks. However, it may be necessary to crack a fitting on the outlet side of the pump to purge entrapped air.

No Load Starting- These pumps are designed to start up with no load on the pressure ports. They should never be started against a load or a closed center valve.

ed periodically for dirt or other contaminants.

If the fluid becomes contaminated the system should be thoroughly drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in a partial or complete loss of filtration.

4. Air bubbles in the reservoir can ruin the pump and other components. If bubbles are seen, locate the source of the air and seal the leak. (See Table 3.)

5. A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer) or preferably pumped through a 10 micron (absolute) filter.

It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of the shaft couplings should be as specified by their manufacturers.

F. REPLACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and materials are used in the manufacture of our parts. Substitutions may result in early failure. Part numbers are shown in the parts drawings listed in Table 2.

TABLE 3 - TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	DRIVEN IN THE WRONG DIRECTION OF ROTATION	The drive direction must be changed immediately to prevent seizure. Refer to section VI.D. for the correct ring position for each direction of rotation.
	COUPLING OR SHAFT SHEARED OR DISENGAGED	Disassemble the pump and check the shaft and cartridge for damage. (See Section VI.) Replace the necessary parts.
	FLUID INTAKE PIPE IN RESERVOIR RESTRICTED	Check all strainers and filters for dirt and sludge. Clean if necessary.
	FLUID VISCOSITY TOO HEAVY TO PICK UP PRIME	Completely drain the system. Add new filtered fluid of the proper viscosity.
	AIR LEAKS AT THE INTAKE. PUMP NOT PRIMING	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is above the intake pipe opening. Check the minimum drive speed which may be too slow to prime the pump.
	RELIEF VALVE STUCK OPEN. (MODELS WITH INTEGRAL RELIEF VALVE ONLY)	Disassemble the pump and wash the valve in clean solvent. Return the valve to its bore and check for any stickiness. A gritty feeling on the valve periphery can be polished with crocus cloth. Do not remove excess material, round off the edges of the lands or attempt to polish the bore. Wash all parts and reassemble the pump.
INSUFFICIENT PRESSURE BUILD-UP	VANE(S) STUCK IN THE ROTOR SLOT(S)	Disassemble the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. If necessary flush the system and refill it with clean fluid.
	SYSTEM RELIEF VALVE SET TOO LOW	Use a pressure gage to correctly adjust the relief valve.
PUMP MAKING NOISE	COMPLETE LOSS OF FLOW FROM PUMP.	-A valve is stuck open permitting free flow to tank. -Broken inlet or pressure line. -Actuator bypassing the full flow. (Motor valve plate lift)
	PUMP INTAKE PARTIALLY BLOCKED	Service the intake strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	AIR LEAKS AT THE INTAKE OR SHAFT SEAL. (OIL IN RESERVOIR WOULD PROBABLY BE FOAMY)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. See that the fluid in the reservoir is above the intake pipe opening.
	PUMP DRIVE SPEED TOO SLOW OR TOO FAST	Operate the pump at the recommended speed.
	COUPLING MISALIGNMENT	Check if the shaft seal bearing or other parts have been damaged. Replace any damaged parts. Realign the coupled shafts.

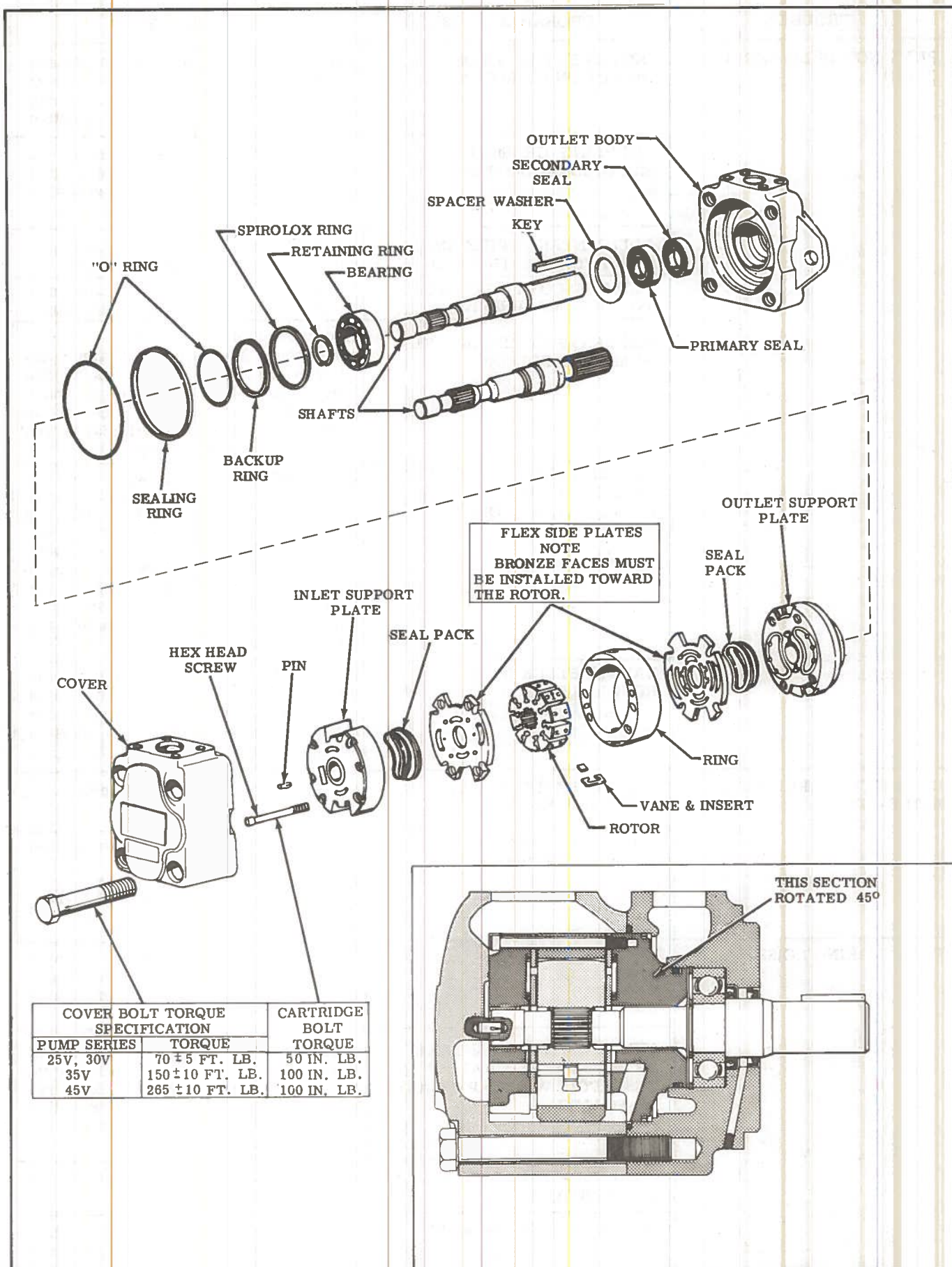


Figure 9 - Exploded and cross-section views of typical pump

G. TROUBLE-SHOOTING

Table 3 lists the common difficulties experienced with vane pumps and hydraulic systems. It also indicates the probable causes and remedies for each of the troubles listed.

NOTE

Complete cartridges are available in service kits for rebuilding these pumps. Refer to the parts drawings listed in Table 2 for part numbers. If a replacement cartridge is being installed, proceed as in step B-1 for disassembly and step D-2 for assembly.

WARNING

Before breaking a circuit connection, be certain that power is off and the system pressure has been relieved. Lower all vertical cylinders, discharge all accumulators and block any load whose movement could generate pressure. Plug all units and cap all lines to prevent entry of dirt into the unit or system.

A. GENERAL

Plug all removed units and cap all lines to prevent the entry of dirt into the system. During disassembly, pay particular attention to identification of the parts, especially the cartridges, for correct assembly. Figure 9 is an exploded view which shows the proper relationship of parts for disassembly and assembly. Refer to Figure 1 and Figure 9 for the correct assembled relationship of the parts. Various steps in the overhaul process are shown in Figures 10 through 22.

B. DISASSEMBLY

1. Basic Pump- Remove the foot mounting and shaft key, if used. Support the pump on blocks or clamp the body in a vise as shown in Figure 10. If a vise is used, use protective jaws to avoid damage to the body and its machined surfaces. Mark the pump body and cover for correct reassembly. Remove four cover screws and lift the cover off the pump.

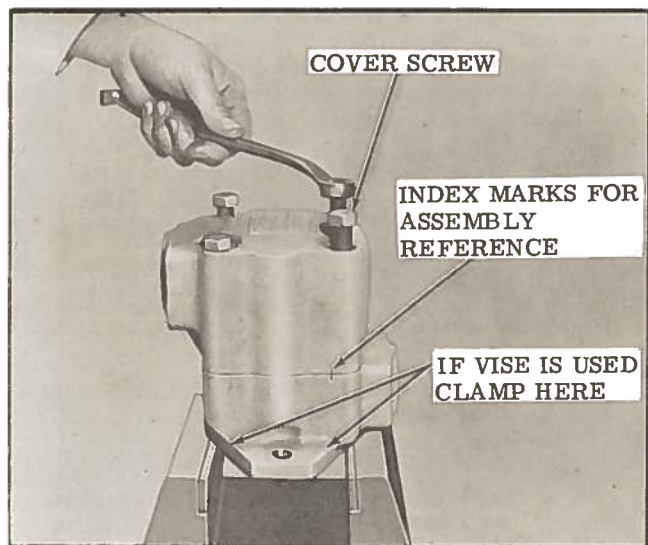


Figure 10 - Beginning Disassembly

SECTION VI - OVERHAUL

It should always be remembered that many apparent pump failures are actually the failures of other parts of the system. The cause of improper operation is best diagnosed with adequate testing equipment and a thorough understanding of the complete hydraulic system.

Remove the cover "O"ring. Pull and/or pry out the cartridge as shown in Figure 11.

Remove the large spirolox ring and pull the shaft and bearing from the body. Drive the shaft seals out of the body. If it is necessary to remove the shaft bearing, first remove the small snap ring and then press the shaft out of the bearing while supporting the bearing inner race.

2. Cartridge disassembly -

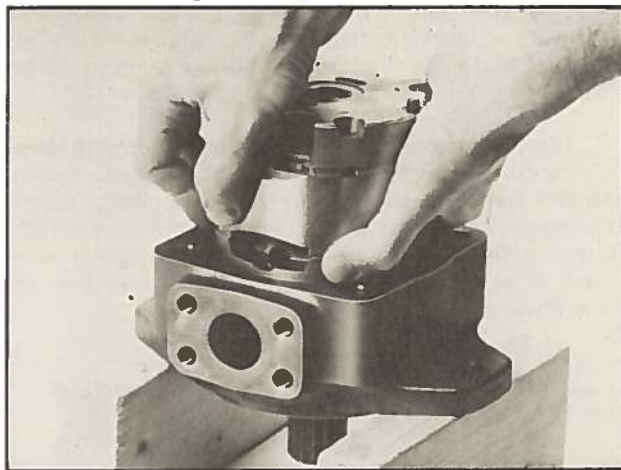


Figure 11 - Cartridge removal

a. Remove the "O"ring, back-up ring and square sealing ring from the outlet support plate.

b. Scribe a line across the outer surface of the cartridge kit. (See figure 12). The scribe marking will provide a reference for parts during assembly.

c. Place the cartridge on a flat surface (outlet support plate down) and remove the two socket head screws.

CAUTION

Do not slide flex side plates across the ring and rotor. Burrs on the ring or rotor can cause deep scratches in the soft brass surface.

d. Slide the inlet support plate and seal packs off the cartridge. DO NOT allow the flex side plate to slide with the support plate. (See figure 13).

Move the flex side plate off center just enough to grab the edge and lift up and away without sliding. (See figure 14).

If a small flat piece of wood is available, place it over the ring and rotor and reverse the cartridge to have the outlet support plate pointing up. (See figure 15). Slide the outlet support plate and seal packs off the cartridge, do not allow the flex side plate to slide with the support plate. Refer to figure 16.

Move the flex side plate off center just enough to lift up and away without sliding. (See figure 17).

Remove the cam ring from the rotor and vanes. Locate the arrow stamped into the rotor periphery. Remove the vanes and inserts in order, starting at the arrow. Keep them in order for inspection. (See figure 18).

NOTE

Do not remove cartridge locating pins from the inlet support plate unless they are damaged. The pins are of a driv-loc type and can be difficult to remove.

C. INSPECTION AND REPAIR

CLEANING. All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement very important. Clean all removed parts, using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination.

1. Discard the shaft seal(s), "O"rings, back-up rings and seal packs. Use a new seal kit for reassembly. Refer to parts drawings noted in Table 2 for kit numbers. Wash the metal parts, blow them dry with air and place on a clean surface for inspection.

2. Check the cartridge wear surfaces for pickup, scoring and excessive wear. Slight heat discoloration of the flex side plate bronze surface is normal. Score marks deeper than .001 inch and scratches deeper than .002 inch indicate a new part is needed. Slight scoring and/or scratches can be removed with an oiled arkansas stone.

CAUTION

DO NOT use a dry stone on the bronze surface or scratches will result.

3. Inspect both sides of each vane and insert in order. If pickup, heavy wear or scoring is found, inspect the appropriate rotor slot. Replace scored parts. Refer to the parts drawings noted in Table 2 for part numbers.

4. Inspect the cam ring for vane chatter marks, wear and/or scratches. Replace if scoring is evident.

NOTE

All cartridge kit parts must be free of burrs. Stone the mating surfaces of each part with an oiled arkansas stone prior to assembly.

NOTE

Pre-assembled replacement cartridge kits are available. If the old cartridge is worn extensively, a new kit should be used. Refer to the parts drawings listed in Table 2.

5. Vane and rotor wear can be checked by inserting the vane in the rotor slot and checking for excessive play. Replace the rotor and vanes if wear is evident.

6. Rotate the bearing while applying pressure to check for wear, looseness and pitted or cracked races.

7. Inspect the seal and bushing mating surfaces on the shaft for scoring or wear. Replace the shaft if marks cannot be removed by light polishing.

D. ASSEMBLY

NOTE

Coat all parts except seals and back-up rings with clean hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold the "O"rings in place during assembly.

IMPORTANT

During handling and shipping of the precision machined cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges on the parts of a new cartridge kit should be stoned prior to installation.

NOTE

To reverse direction of a new cartridge kit, simply reverse location of the inlet and outlet support plates, and realign the cartridge with the cover. See steps V.D.1. h thru j.

1. Cartridge - The direction of rotation is as viewed from the shaft end; right hand rotation is clockwise; left hand, counterclockwise.

NOTE

If locating pins were removed from the inlet support plate, install new pins with locking flutes located within the inlet support plate. Drive the new pins into the support plate, with a soft tip hammer.

a. Place the inlet and outlet support plates on a flat surface as shown in figure 19. Install seal packs into cavities with seal retainer surface up. ("O"rings facing downward into the cavities.)

b. Place a flex side plate over each of the support plates with bronze wear surface facing up. Align scribe marks to make sure the correct flex side plate is used with the correct support plate.

NOTE

Flex side plates develop a wear pattern with the rotor and vanes and should not be interchanged.

c. For right hand rotation units, set the rotor on the flat wooden board with the arrow pointing right. (For left hand rotation the arrow should point left.) Assemble the vanes and inserts into the rotor in reverse order. (See figure 18). Make sure the sharp chamfer edge of each vane leads in the direction of rotation. All vanes must move freely in the rotor slots with no evidence of bind.

d. Assemble the cam ring over the rotor and vanes with the arrow pointing in the same direction as the rotor. Lubricate the top surface of the rotor and vanes liberally with system fluid.

e. Locate the scribe mark on the cam ring, the outlet support plate, and the flex side plate.

Hold the outlet support plate and flex side plate together and assemble over the cam ring and rotor with the scribe marks in-line.

f. Hold the cartridge together to prevent movement and turn the assembly over so the outlet support

plate rests on a flat surface, and the flat wooden board is up. (See figure 20). Remove the flat wooden board.

g. Lubricate the exposed surface of the rotor and vanes with system fluid. Locate the scribe mark on the inlet support plate and flex side plate. Hold the inlet support plate and flex side plate together and assemble over the cam ring and rotor with scribe marks in-line. (See figure 21).

NOTE

The cast-in arrows located next to the socket head screws, indicate cartridge direction of rotation.

h. Thread the two socket head screws into the cartridge until snug, (hand tight).

NOTE

The O.D. of all component parts of the cartridge kit must be in-line with each other or the cover cannot be installed. Align the cartridge as follows:

i. Install the cover over the cartridge. Tap lightly on the cover with your hand until each part centers. Remove the cover gently so as not to disturb alignment. Torque socket head screws to the torque noted on figure 9, and recheck kit alignment with the cover. Repeat until cartridge kit is aligned. (See figure 22.)

j. Check the rotor for bind by inserting the index finger through the shaft opening of the inlet support plate. Hold the cartridge kit in a horizontal shaft position and lift the rotor with the finger. The rotor should move freely back and forth within the cartridge. If the rotor binds, open the kit, clean and stone all possible areas of bind, then reassemble using the aforementioned procedure. The rotor MUST move freely within the cartridge when assembled.

2. Basic Pump - Clamp the body in a vise or place on 2x4 wooden blocks to facilitate assembly. (See figures 10 and 11.)

a. Lubricate the primary shaft seal with petroleum jelly and place in position within the body, garter spring up. See figure 5 for seal arrangements.

b. Use the seal installation tool shown in figure 8 to prevent damage to the seal. Press the seal into the body until it bottoms out.

NOTE

Two shaft seal arrangements are available in

the VQ pump series. See figure 5 and table 1. If the pump model code (table 1) indicates that a secondary seal is required, perform the following step.

c. Lubricate the secondary seal with petroleum jelly and place the seal in position against the shaft end of the body. See figure 5b. Use a small hardwood block to drive the seal evenly into the body. Installation is complete when the seal face is flush with the front of the body. DO NOT drive the seal past flush as it can block the body drain opening.

NOTE

If the shaft bearing was defective, install a new bearing as follows:

d. Press the shaft into the new bearing with an arbor press while supporting the bearing inner race. Refer to figures 5 and 9 for correct location of bearing on the shaft. Install a small snap ring behind the bearing.

e. Place the bearing spacer washer over the shaft, against the front of the bearing. Use a "bullet" over the shaft end to prevent damage to the seal(s). Lubricate the "bullet" with petroleum jelly and carefully push the shaft through the seals until the bearing and spacer is in location within the body. Install the large spirolox ring into the body snap ring groove behind the bearing.

f. Install the square sealing ring into the body. See figures 1 and 9 (sectional view) for location.

g. Install the "O" ring and back-up ring on the cartridge, outlet support plate hub. See figure 9 for location.

h. Carefully install the cartridge into the body so one of the chamfers on the cam ring aligns with the cover inlet port.

i. Lubricate and install the large cover to body "O" ring in place.

j. Install the cover in position; move back and forth until the cartridge pins drop into the cover holes.

k. Oil and install the cover to body bolts, (4 required). Torque to the value noted in figure 9.

l. Turn the pump shaft by hand to verify freedom of the cartridge.

SECTION VII - TESTING

Vickers Industrial and Mobile application engineering personnel should be consulted for test stand circuit requirements and construction. If test equip-

ment is available, the pump should be tested at the recommended speeds and pressures shown on the installation drawings (See Table 2).

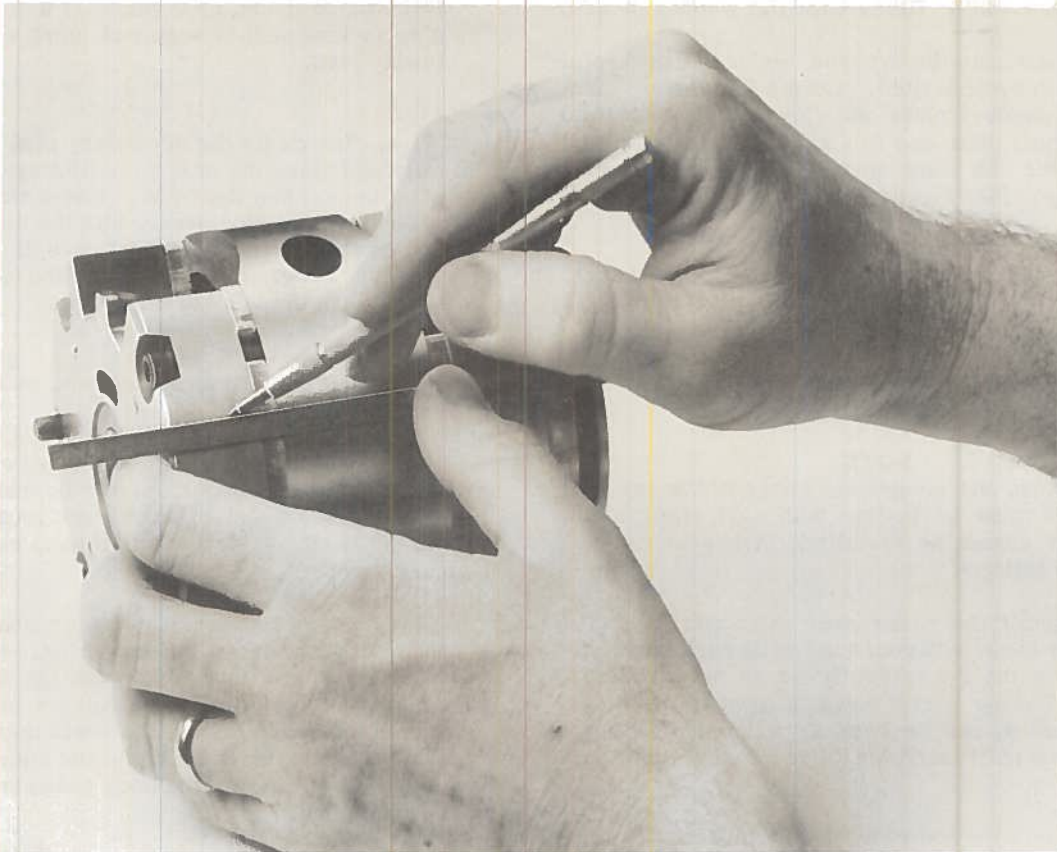


Figure 12 - Scribing the cartridge.

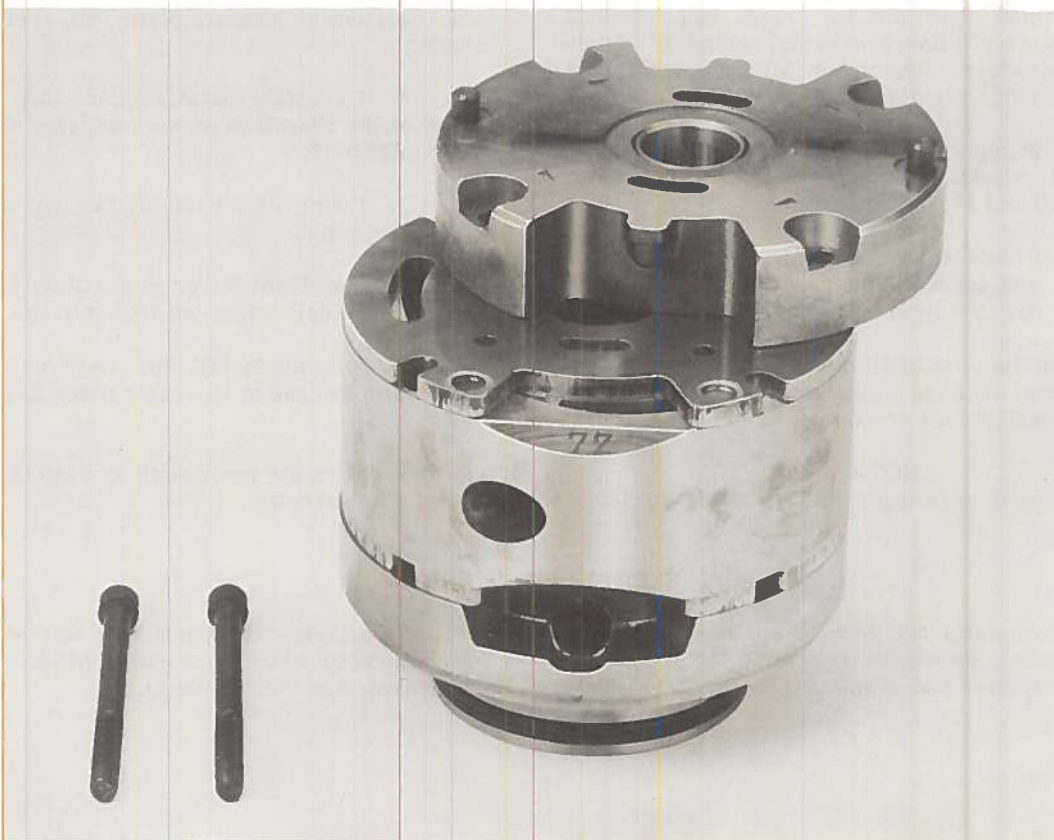


Figure 13 - Inlet support plate removal.

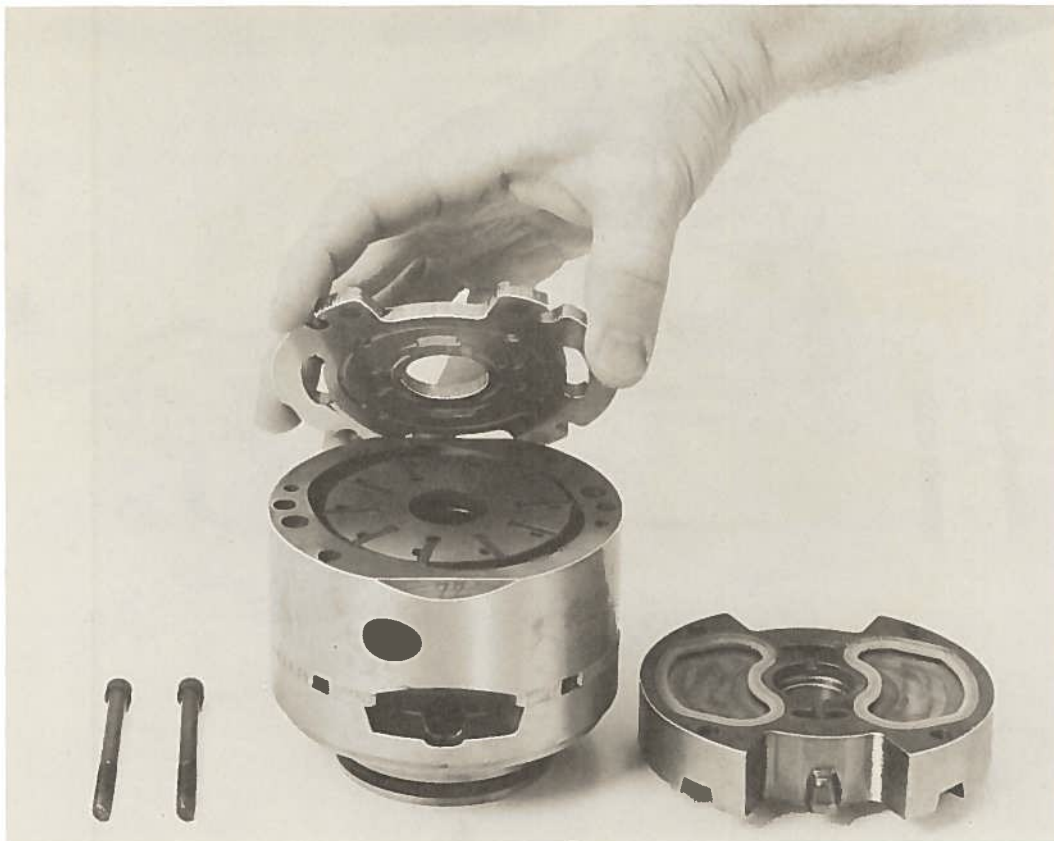


Figure 14 - Inlet flex side plate removal.

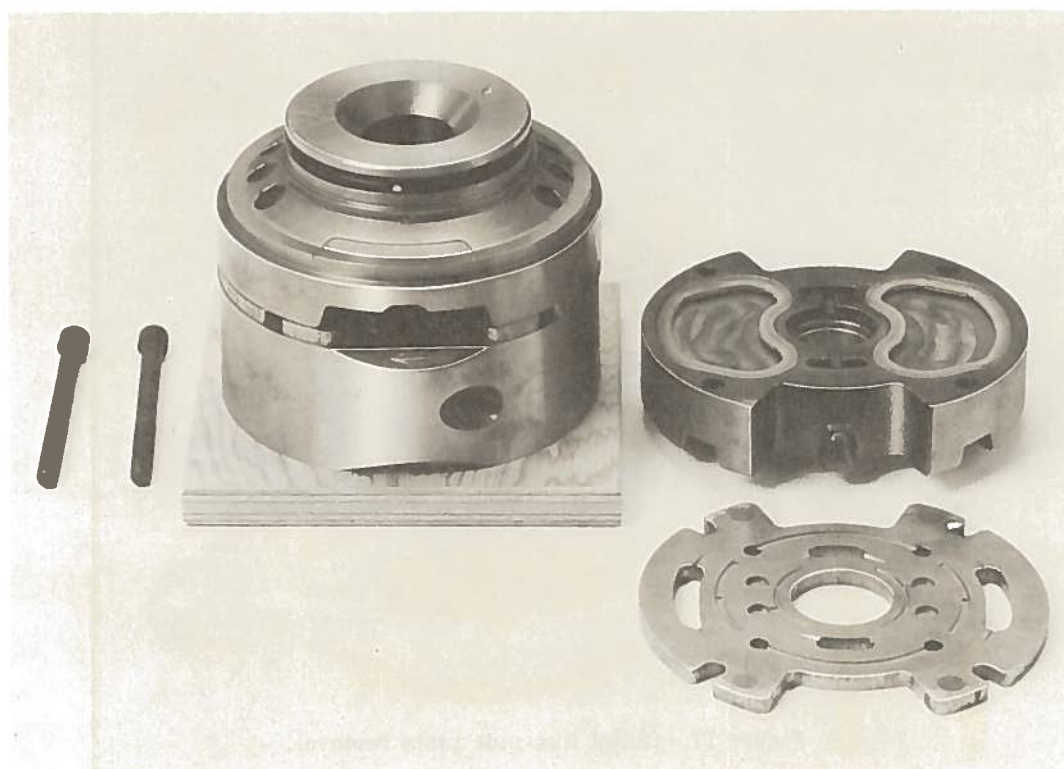


Figure 15 - Reverse cartridge, use a piece of wood to hold ring, rotor and vanes.

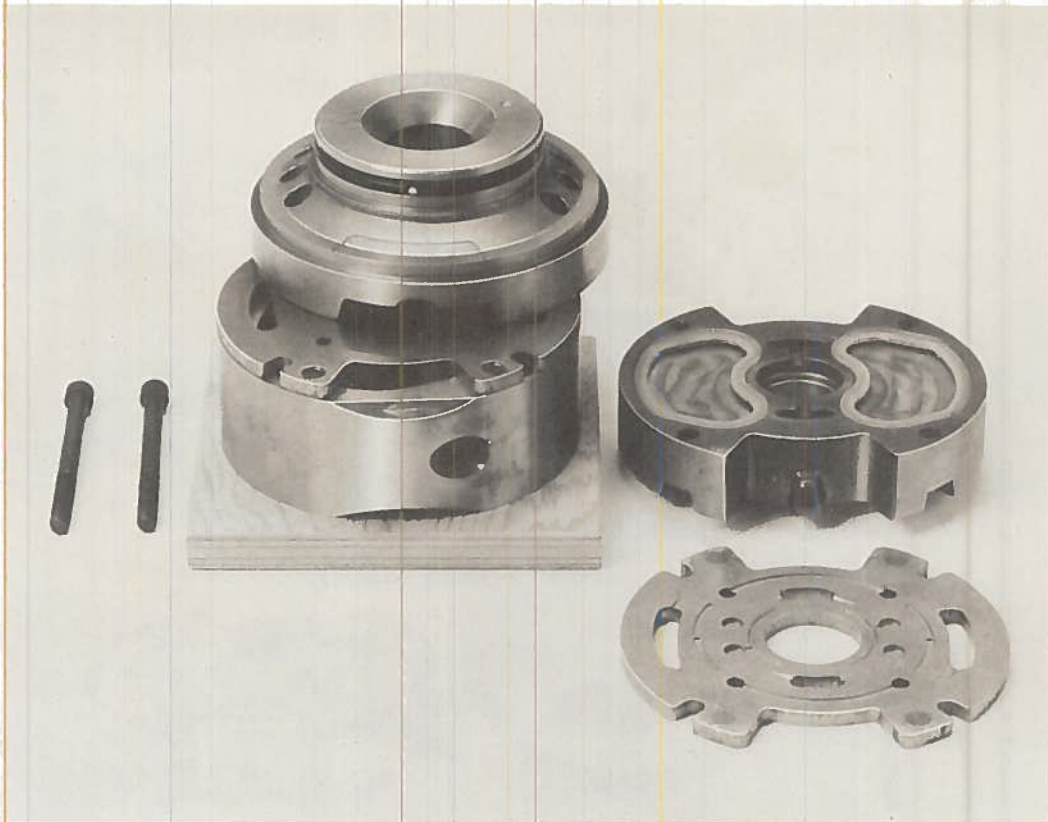


Figure 16 - Outlet support plate removal.

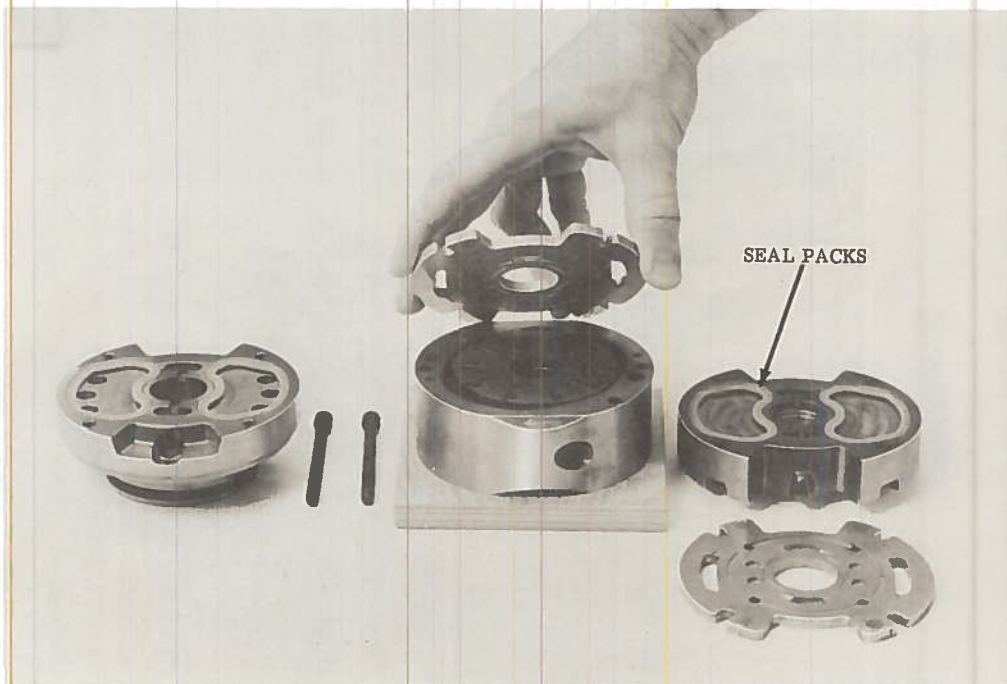


Figure 17 - Outlet flex side plate removal.

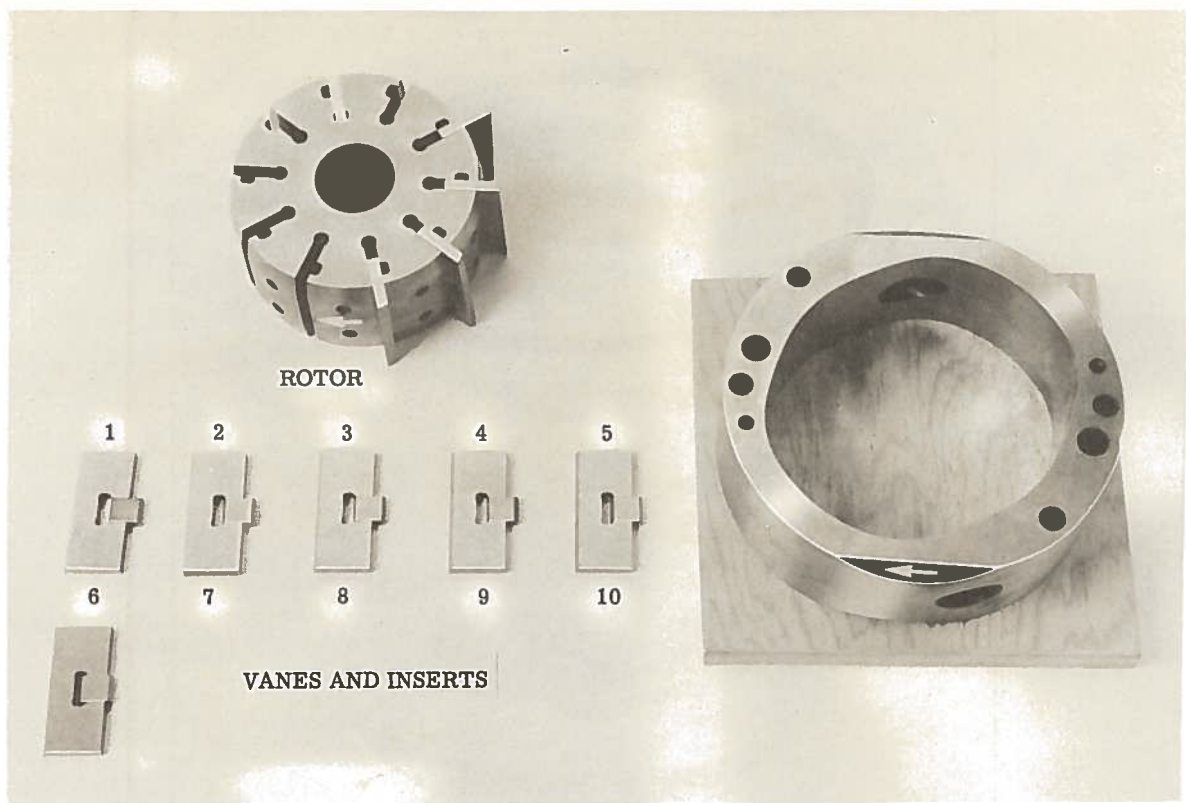


Figure 18 - Sequential removal of vanes from rotor,
Starting at arrow on rotor.

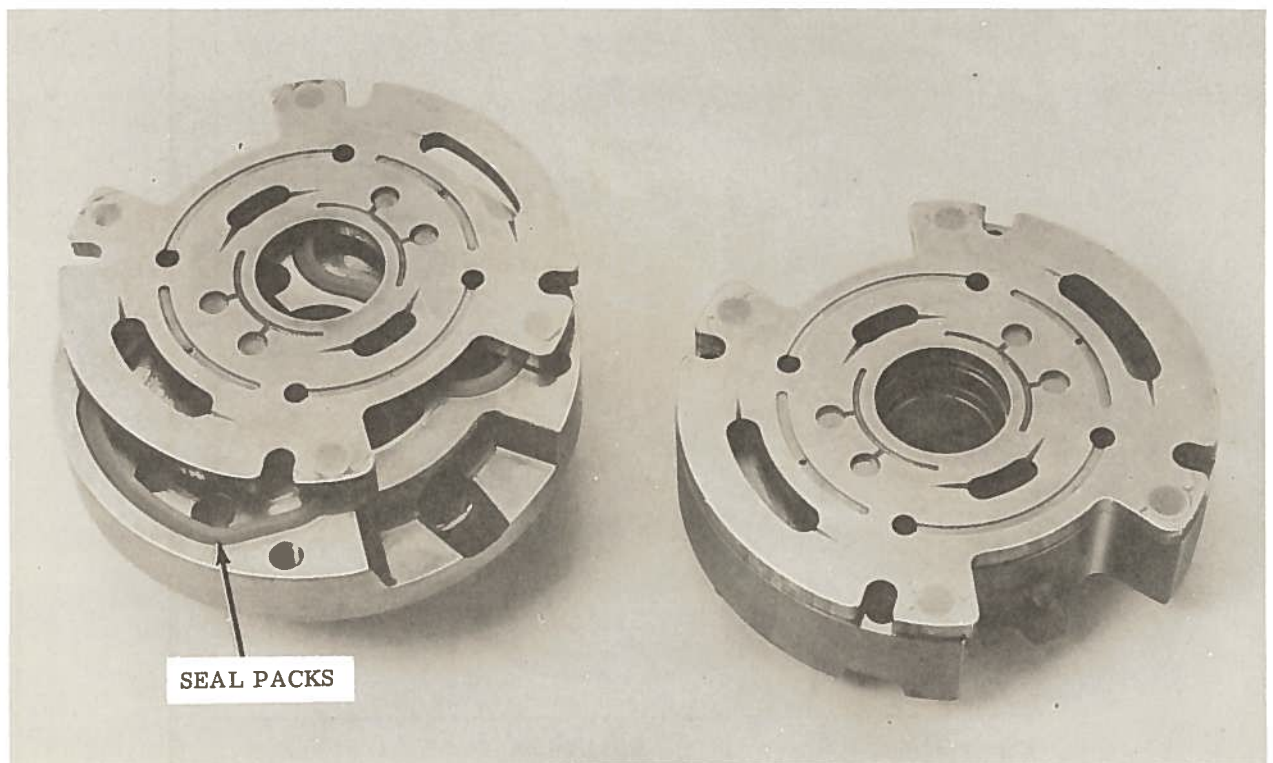


Figure 19 - Assembly of flex side plates over seal packs
onto the inlet and outlet support plates.

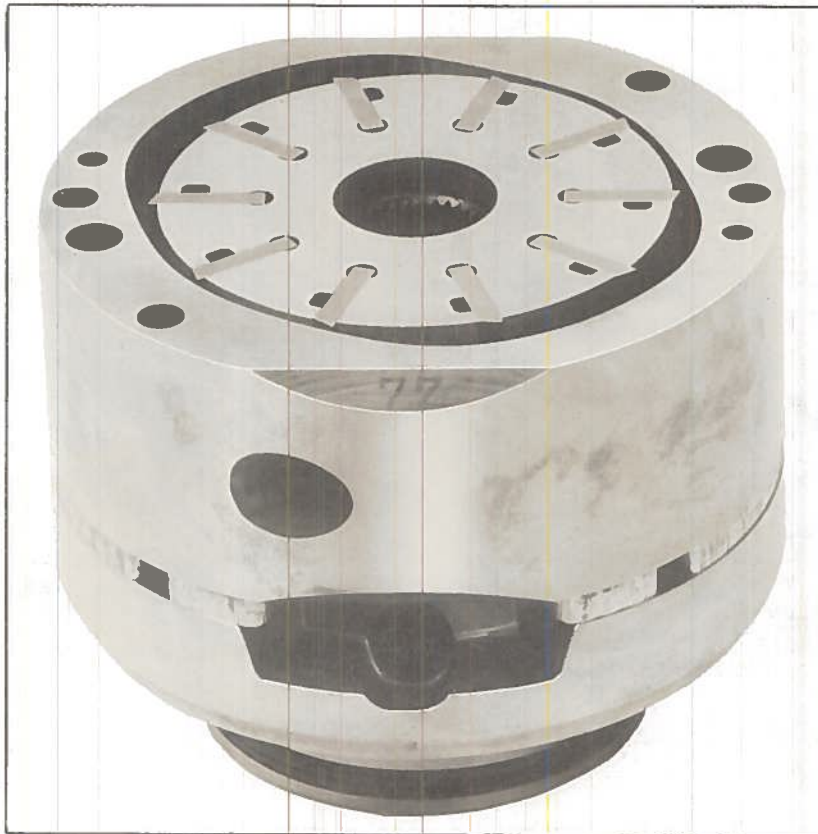


Figure 20 - Outlet support plate and flex side plate assembled to cartridge.
Ready for installation of inlet support plate and flex side plate.

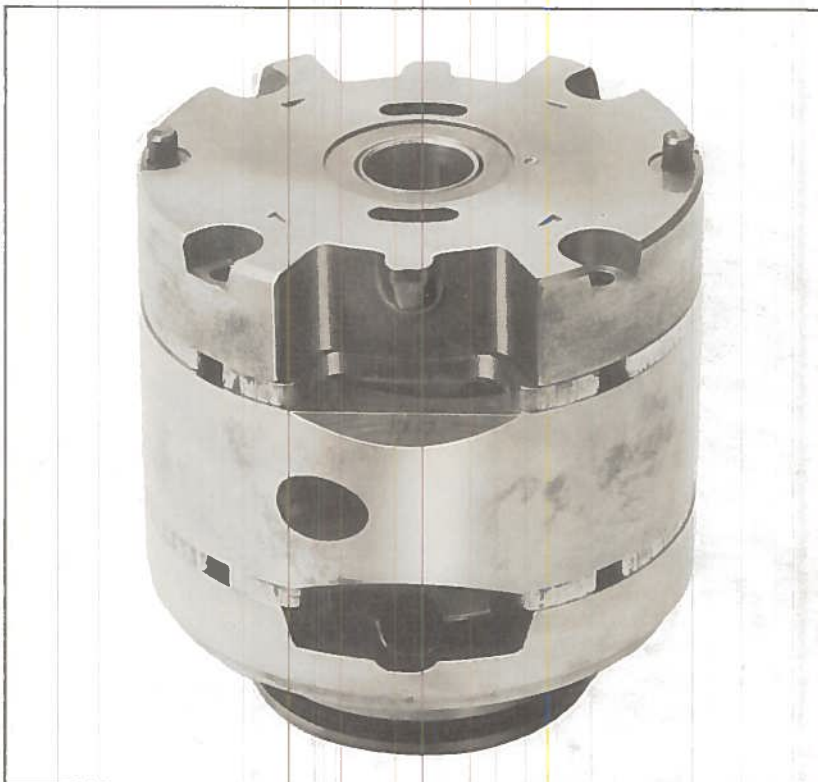


Figure 21 - Cartridge ready for installation of socket head screws.

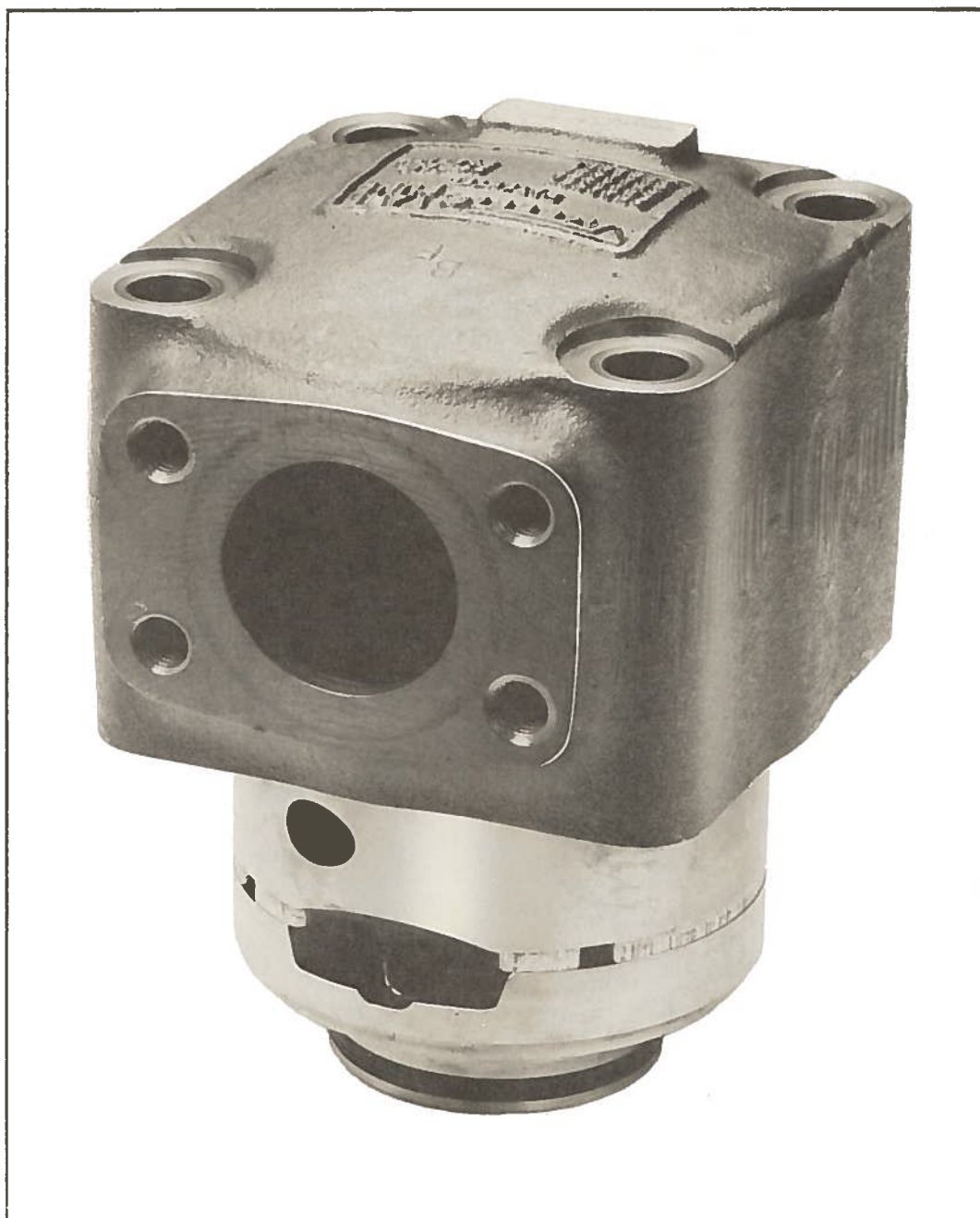
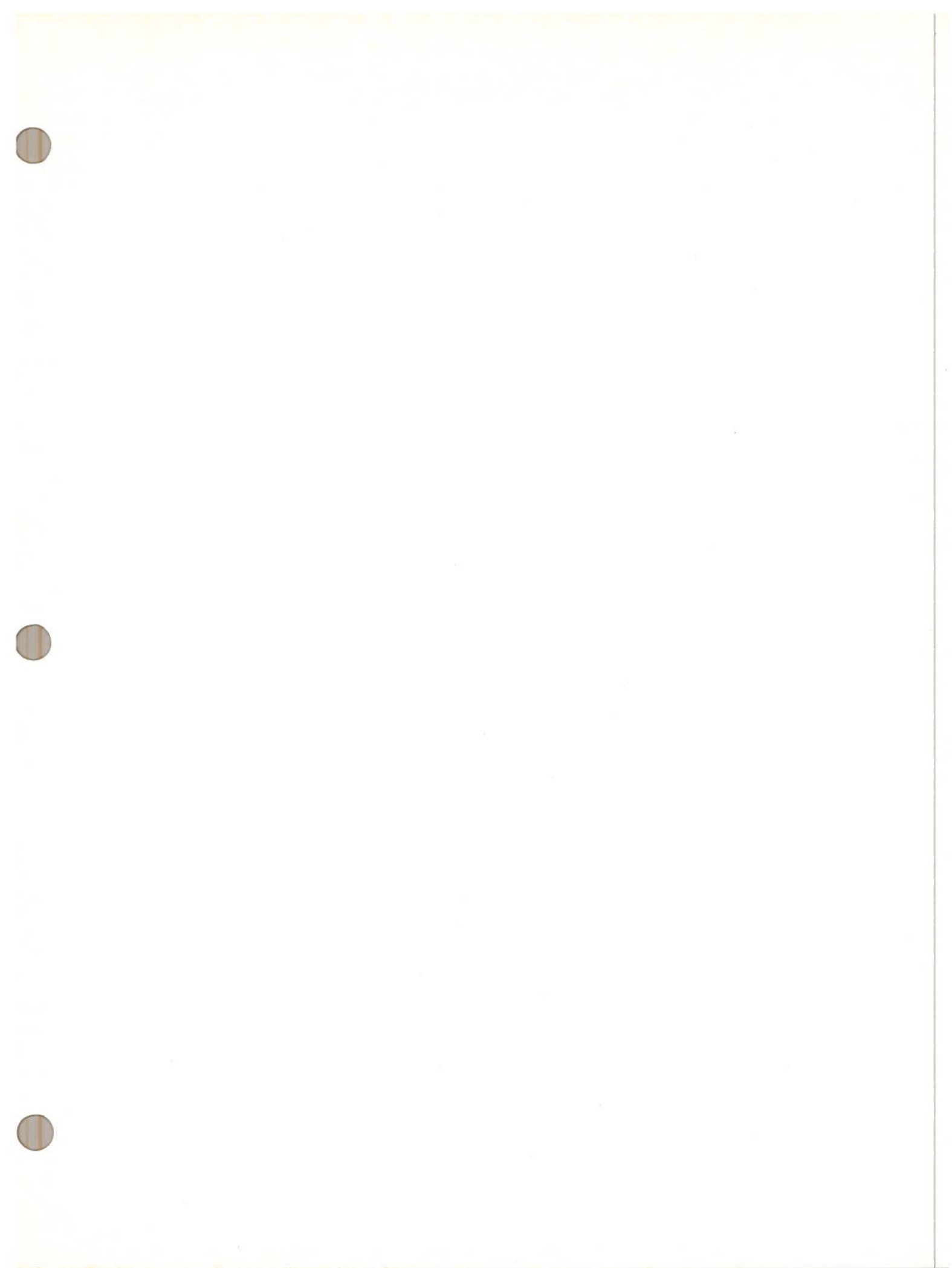


Figure 22 - Aligning cartridge kit with cover.





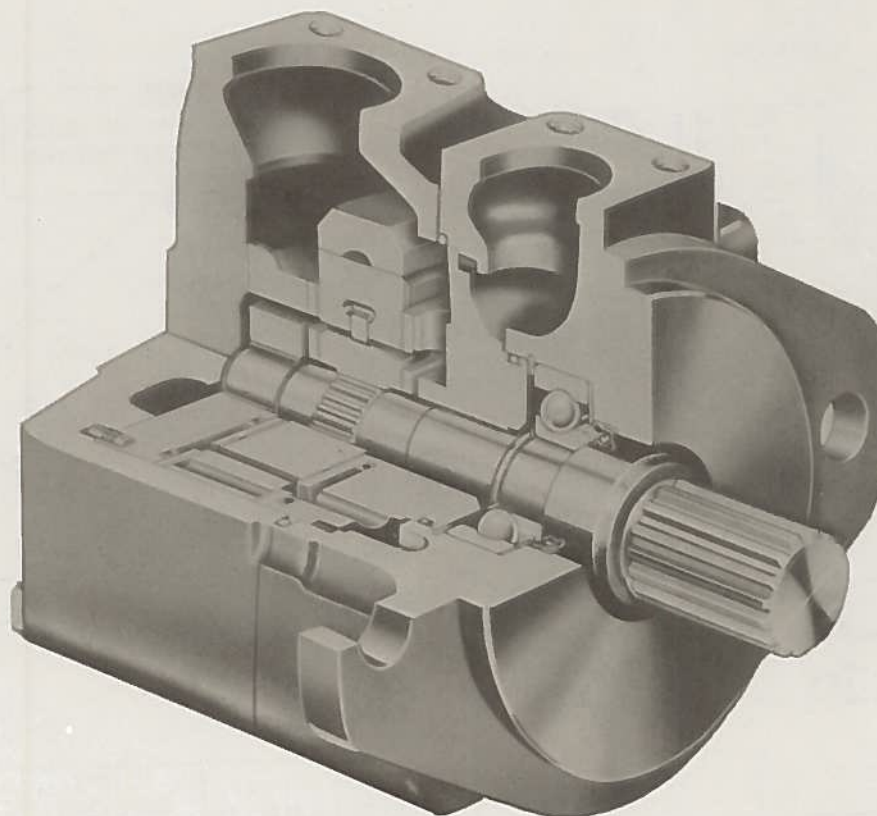
A TRIMMOVA COMPANY

Service Parts Information

Vane
Type
Single
Pumps

25VQ ***-***-**-20
26VQ ***-***-**-20
30VQ ***-***-**-20
31VQ ***-***-**-20

5

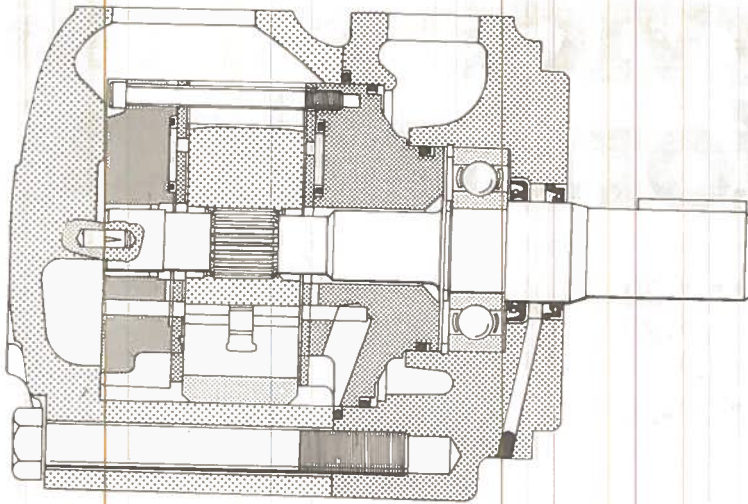


Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

Revised 3-1-87

I-3165-S



⊖ TO REVERSE CARTRIDGE KIT ROTATION, REMOVE THE TWO (2) 413834 SCREWS, AND REVERSE THE LOCATION OF THE INLET SUPPORT PLATE 430805 AND OUTLET SUPPORT PLATE 419079. REINSTALL THE TWO (2) SCREWS HAND TIGHT. USE PUMP COVER TO ALIGN ALL SECTIONS OF THE CARTRIDGE. REMOVE COVER CAREFULLY AND TIGHTEN SCREWS TO 50 lb. in. TORQUE.

□ WIPE O.D. OF SEAL WITH OIL BEFORE PRESSING INTO BODY. APPLY GREASE TO SEAL I.D. BEFORE INSTALLATION OF SHAFT.

▲ INCLUDED IN SINGLE
SHAFT SEAL KIT 920021
F3 EQUIVALENT 920023

▲ INCLUDED IN DOUBLE
SHAFT SEAL KIT 920022
F3 EQUIVALENT 920024

* INCLUDED IN
CARTRIDGE KIT

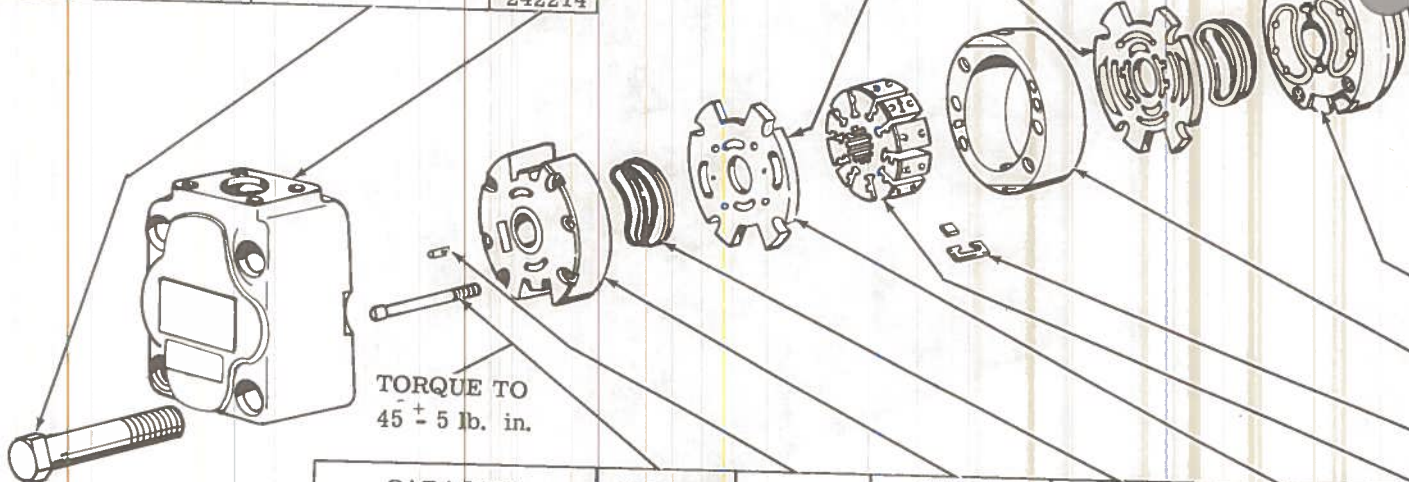
*▲ 588507

*▲ 1540'

*▲ 419673 RING SEAL
(ASSEMBLY NOTE
IN BODY BEFORE
INSTALLATION OF CARTRI
*▲ 154095 "O" RI

MODEL DESIGNATION	SCREW (4 REQ'D) (TORQUE TO 65-75 lb. ft.)	COVER
2*VQ*A/C-(*)***-20(*)	96168	224309
2*VQ*B/D-(*)***-20(*)		242215
3*VQ*A/C-(*)***-20(*)	119805	224526
3*VQ*B/D-(*)***-20(*)		242214

NOTE
BRONZE FACES MUST
BE INSTALLED TOWARD
THE ROTOR.



NOTE:
USE 25VQ PARTS TO
SERVICE 25V -10/12
DESIGN UNITS.

CAPACITY (USGPM)	SCREW (2 REQ'D)	PIN (2 REQ'D)	INLET SUPPORT PLATE	▲ SEAL PACK (4 REQ'D)	FLEX-SIDE PLATE KIT	RC
2*VQ12A-(*)***-20(*)	413834	422207	430805 (INCLUDES BUSHING)	433764 S/A	923956	THESE PARTS ARE INCLUDED IN CA
2*VQ14A-(*)***-20(*)						
2*VQ17A-(*)***-20(*)						
2*VQ19A-(*)***-20(*)						
2*VQ21A-(*)***-20(*)						
3*VQ24A-(*)***-20(*)	416454					
3*VQ28A-(*)***-20(*)						

WARNING: USE THIS DRAWING FOR PARTS INFORMATION ONLY. SEE OVERI

ASSEMBLE SEAL WITH SPRING LOADED SEALING MEMBER TOWARD BEARING.

● ASSEMBLE SEAL FLUSH WITH PILOT FACE WITH SPRING LOADED SEALING MEMBER FACING INWARD AS SHOWN.

MOUNTING ASSEMBLY **VQ***F-**-20(L)		
INCLUDED IN MOUNTING KIT FB-B-10	SCREW (2 REQ'D) 205533	MOUNTING BRACKET 199491

BODY S/A	MODEL
942353	2*VQA/D-**-20
942378	2*VQB/C-**-20
942354	3*VQA/D-**-20
942378	3*VQB/C-**-20

L	TYPE DUTY	BEARING
	STANDARD	1705
	HEAVY DUTY	232750
	STANDARD	1705
	HEAVY DUTY	232750

20128 SNAP RING

20128 SNAP RING

20128 SNAP RING

20128 SNAP RING

20128 SNAP RING
(SEE TABLE)

△□● 429283 SHAFT SEAL (USE ON "S" FLANGE MOUNTED MODELS ONLY)

△□□ 394976 SHAFT SEAL

190362 WASHER

KEY
(SEE TABLE)

KEY
(SEE TABLE)

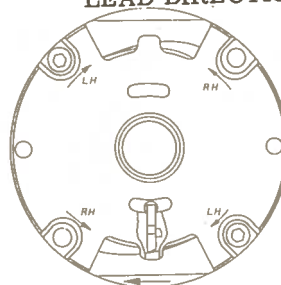
SCREW
(SEE TABLE)

NUT
(SEE TABLE)

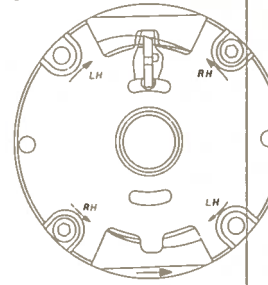
SHAFTS				KEY	NUT	TYPE
SINGLE SEAL MODELS		DOUBLE SEAL MODELS				
SHAFT NO.	PART NO.	SHAFT	PART NO.			
1	238755	—	—	9955	—	STRAIGHT, KEYED
3	242747	—	—	1617	18755	KEYED WITH NUT
6	242767	—	—	1617	—	KEYED SHAFT
11	238929	—	—	—	—	SPLINE
86	419082	—	—	3418	—	STRAIGHT, KEYED, HEAVY DUTY

VANE KIT (10 VANES & 10 INSERTS)	RING	OUTLET SUPPORT PLATE	CART. KIT	F3 CART. KIT
922710	326984 326985 326986 326987 326988	419079	416439 416440 416441 421232 416442	421570 421571 421572 421573 421574
922648	234470 224525		417052 416452	421645 421646

SHARP EDGE OF VANE MUST LEAD DIRECTION OF ROTATION



COVER END
L.H. ROTATION



COVER END
R.H. ROTATION

MANUAL I-3144-S FOR MAINTENANCE INFORMATION

MODEL CODE BREAKDOWN

****VQ**A**-***-20(L)**

SERIES
25, 26, 30, 31

FLEX SIDE PLATE
VANE PUMP

SAE RATED CAPACITY
(1200 RPM - 100 PSI)
SEE CAPACITY (USGPM) IN TABLE.
(EXPLODED VIEW)

ROTATION
(VIEWED FROM SHAFT END)
L - LEFT HAND, CCW ROTATION
OMITTED - RIGHT HAND

DESIGN NUMBER

PORT POSITIONS

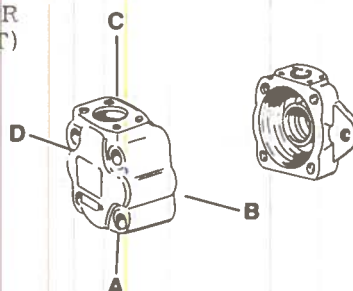
SHAFTS - SEE TABLE
(EXPLODED VIEW)

PORT CONNECTIONS		
CODE	INLET CONNECTION	OUTLET CONNECTION
A	SAE 4-BOLT	SAE 4-BOLT
B	SAE STR. THREAD	SAE STR. THREAD
C	SAE 4-BOLT	SAE STR. THREAD
D	SAE STR. THREAD	SAE 4-BOLT

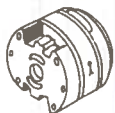
MOUNTING & SHAFT SEALS ASSEMBLY
F-FOOT (SINGLE SHAFT SEAL ASSEMBLY)
S-FLANGE (DOUBLE SHAFT SEAL ASSEMBLY)
OMITTED-FLANGE (SINGLE SHAFT SEAL ASSEMBLY)

COVER
(INLET)

BODY
(OUTLET)



MODEL	INLET COVER POSITIONS (VIEWED FROM COVER END)
VQA-***A-20(L)	OPPOSITE OUTLET PORT
VQA-***B-20(L)	90° CLOCKWISE FROM OUTLET
VQA-***C-20(L)	IN-LINE WITH OUTLET
VQA-***D-20(L)	90° COUNTERCLOCKWISE FROM OUTLET



WHEN ORDERING SPARE CARTRIDGE PARTS, IT IS RECOMMENDED THEY BE OBTAINED IN CARTRIDGE KITS. KITS ARE ASSEMBLED AND TESTED BY VICKERS FOR EITHER RIGHT OR LEFT HAND ROTATION. IF LEFT HAND ROTATION IS REQUIRED, IT SHOULD BE SPECIFIED ON PARTS ORDER BY ADDING SUFFIX "L" TO CARTRIDGE KIT NUMBER: FOR EXAMPLE, 416439-L.

For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

-LABORATORY WORK SHEET-

25VQ SINGLE INTRA-VANE PUMPS

 I. PRELIMINARY OBSERVATION

- A. What is model number of pump? _____
- B. Drive shaft rotation indicated: R.H. _____ L.H. _____
- C. What type of mounting is used or provided for?
 Face _____ Foot _____
- D. Where is the inlet port located?
 Body _____ Cover _____
- E. Inlet and outlet port connections have provisions for:
 Flange _____ Straight Thread _____ Pipe _____

 II. DISASSEMBLY

- A. Loosen the 4 hex head bolts and remove the pump cover.
- B. Remove the pump cartridge (grasp cartridge and rotate slightly while pulling outward from body).
1. Note condition of "O" ring and square cut ring. Concave side of backup ring should be adjacent to "O" ring.
 2. Note direction of rotation indicated on ring.
 L.H. _____ R.H. _____
 3. What is GPM rating of cartridge as indicated on ring?
 _____ GPM at _____ RPM.
- C. Remove the two screws from the cartridge and remove the inlet support plate, flex plate and seal packs. Are the rotor and vanes installed properly in the cam ring? _____
- D. Now remove the cam ring, rotor, vanes, outlet support plate, flex plate, and seal pack.
1. Examine above parts for wear, score marks, burrs, etc..
 2. State condition of each (good or worn):
 Inlet support plate _____ Outlet support plate _____
 Ring _____ Rotor _____ Vanes _____ Seal packs _____
 Flex plates _____
- E. How is "slippage" or internal leakage oil disposed of?
 Explain: _____

II. DISASSEMBLY (CONTINUED)

F. . Removal of drive shaft and bearing assembly from pump body. This can be accomplished by removing the spiral lock ring (retaining outer race of bearing) with a screw driver and remove drive shaft and bearing subassembly.

1. Is drive shaft bearing in good condition? Yes___ No___
2. Is surface of the drive shaft which comes in contact with shaft seal in good condition? Yes___ No___
3. Remove flat washer.
4. What is the condition of the shaft seal?
Good___ Replace___

III. LIST MISSING PARTS AND NOTIFY INSTRUCTOR

IV. ASSEMBLY (Reverse pump rotation from that indicated when you disassembled pump.)

- A. Insert flat washer into pump body.
- B. Slide drive shaft and bearing assembly back into pump body and secure with spiral lock ring. Check to see if spiral lock ring is in proper groove.
- C. Assemble cartridge (ring, rotor, vanes, flex plates, seal packs and support plates.)
 1. Insure that the flats on the cam ring line up with the inlet ports in the flex plates and support plates.
 2. Make sure the vane inserts are located in the vanes before placing them in the rotor slots.
 3. Be certain vane chamfer trails direction of rotation.
 4. Install socket head screws loosely.
 5. Place cover bore over cartridge to align parts.
 6. Tighten socket head screws and recheck alignment. Repeat No. 4 if necessary.

IV. ASSEMBLY (CONTINUED)

- D. Position square cut ring in body bore (just past chamfer).
- E. Position large "O" ring in recess in body.
- F. Slip cartridge on drive shaft and into body bore.
- G. Replace cover. Note that dowel pins must engage holes in internal ribs of cover.
- H. Port positions can now be arranged by rotating cover and cartridge together to desired position. (Be careful not to disengage cover from dowel pins in cover.)
- I. Replace 4 hex bolts.

V. SHOW THE PUMP IN GRAPHIC FORM

VI. CHECK WITH INSTRUCTOR

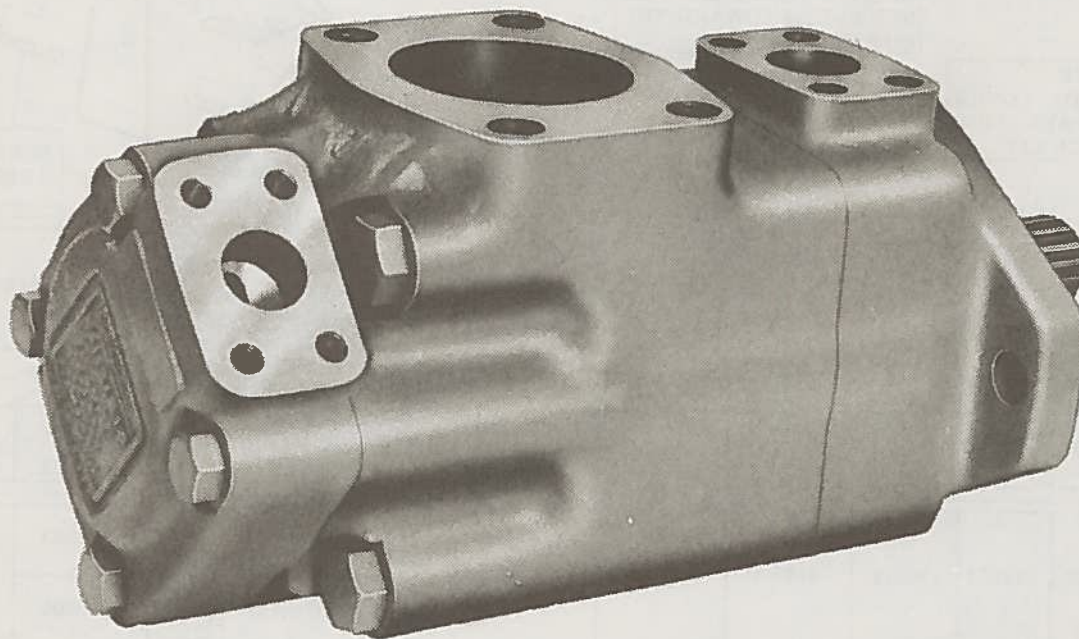


Service Parts Information

**Double
Pumps**

2520VQ -20 Design

6



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised **3-1-87**

I-3166-S

MODEL	COVER TYPE	COVER S/A
252*VQ*A/F*...****20	4-BOLT	250824
252*VQ*C/E*...****20	STRAIGHT THREAD	252504
252*VQ*C/E*...***2*20	FLOW CONTROL	257560
252*VQ*C/E*...***4*20	FLOW CONTROL	257561
252*VQ*C/E*...***6*20	FLOW CONTROL	257562
252*VQ*C/E*...***7*20	FLOW CONTROL	257563
252*VQ*C/E*...***8*20	FLOW CONTROL	257564
252*VQ*C/E*...***10*20	FLOW CONTROL	257565
252*VQ*C/E*...***12*20	FLOW CONTROL	257999

MODEL	RELIEF VALVE SETTING (PSI)	RELIEF VALVE S/A
252*VQ***...****C20	750	232794
252*VQ***...****D20	1000	232795
252*VQ***...****E20	1250	232796
252*VQ***...****F20	1500	232797
252*VQ***...****G20	1750	232798
252*VQ***...****H20	2000	232799
252*VQ***...****J20	2250	233019
252*VQ***...****K20	2500	233020

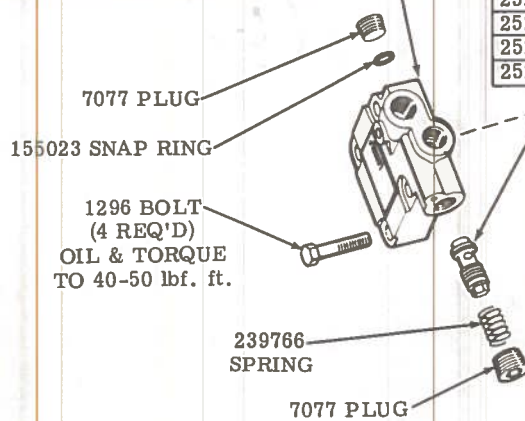
WIPE O.I.
BEFORE PRESSING
PLY GREASE TO SE
INSTALLATION OF

ASSEMBLY
WITH SP
WARD B.

ASSEMBLY
PILOT F
FACING

BRONZE
INSTA
ROTOI

**20VQ MODELS
ONLY NOT FOR
12 & 14 RING
SIZES.



NOTE
BRONZE FACES MUST BE
INSTALLED TOWARD THE
ROTOR.

*NOTE
INSTALL INTO COVER
BEFORE INSTALLATION
OF CARTRIDGE KIT.

38523 BOLT (4 REQ'D)
OIL & TORQUE
TO 65-75 lbf. ft.

251263 HOUSING
(INLET)

SCREW (2 REQ'D)	PIN (2 REQ'D)	PL
413834	422207	430 S,

TORQUE TO
45 ± 5 lbf. in.
TORQUE TO
30 ± 5 lbf. in.

BACK-UP ▲ RING	▲ "O" RING	*▲ SEAL RING	▲ "O" RING	OUTLET SUPPORT PLATE	▲ SEAL PACK (4 REQ'D)	▲ FLEX SIDE PLATE KIT	ROTOR	VANE KIT (10 VANES & INSERTS)	RING	INLET SUPPORT PLATE	PIN (2 REQ'D)	SCREW (2 REQ'D)
THESE ARE INCLUDED IN CARTRIDGE KIT												
588506	154026	419672	154090	419500	433762 S/A	923955	402690	922741	333624 333625 374799	419502	422206	416426
							403539	922743	333626 353901 353902	419501		
							428698	922741	333624 333625 374799	419502		
							428699	922743	333626 353901 353902	419501		

WITH OIL
BODY. AP-
BEFORE
F.

L
D
:

L FLUSH TO
WITH SPRING
D AS SHOWN

FE
ES MUST BE
OWARD THE

SHAFT NO.	TYPE	SECONDARY SHAFT SEAL	2*20 SHAFT	2*21 SHAFT	KEY
1	STR. KEYED		254964	252737	9955
11	SPLINE		254848	252736	
123	SPLINE	429283	413433		

MODEL	BODY	TYPE
2*2*VQ*A/E*--*20	942353	4-BOLT
2*2*VQ*C/F*--*20	942378	STR THD

MODEL	LOCK RING	RETAINING RING	BRG.
252*VQ*****_***20	191400	120128	1705
262*VQ*****_***20			232750

190362
WASHER

□□▲394976 PRIMARY
SHAFT SEAL

▲ SECONDARY
SHAFT SEAL
□ (SEE TABLE)

Φ199740 SCREW
(2 REQ'D)

Φ199491
BRACKET

Φ INCLUDED IN FOOT
BRACKET KIT FB-B-10

STD/F3 SEAL KITS			
▲ STD SINGLE SHAFT	▲▲ STD DOUBLE SHAFT	F3 SINGLE SHAFT	F3 DOUBLE SHAFT
920040	920041	920042	920043

33764 S/A	■ FLEX SIDE PLATE KIT	ROTOR	VANE KIT (10 VANES 10 INSERTS)	RING	OUTLET SUPPORT PLATE	"O" RING	* SEAL RING	"O" RING	BACK-UP RING	STD CART. KIT	F3 CART. KIT	MODEL
THESE PARTS ARE INCLUDED IN CARTRIDGE KIT												
				326984						416439	421570	2*2*VQ12****_***20
				326985						416440	421571	2*2*VQ14****_***20
				326986	419079	154095	419673	154078	588507	416441	421572	2*2*VQ17****_***20
				326987						421232	421573	2*2*VQ19****_***20
				326988						416442	421574	2*2*VQ21****_***20

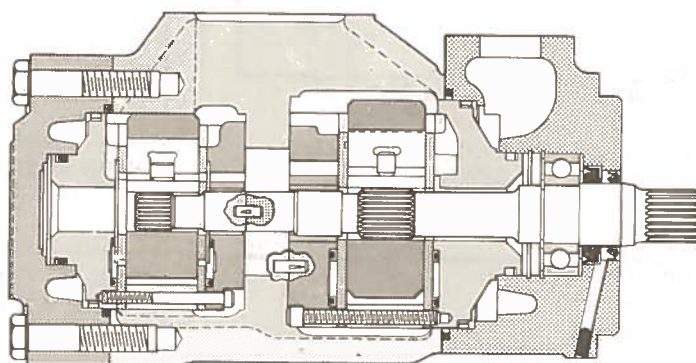
D UDGE	F3 CARTRIDGE KIT	MODEL
053	421588	2*20*** 5**_***20
054	421589	2*20*** 8**_***20
096	423097	2*20*** 9**_***20
127	421590	2*20***11*_***20
128	421591	2*20***12*_***20
129	421592	2*20***14*_***20
100	428707	2*21*** 5**_***20
101	428708	2*21*** 8**_***20
102	428709	2*21*** 9**_***20
103	428710	2*21***11*_***20
104	428711	2*21***12*_***20
105	428712	2*21***14*_***20

*INSTALL SEAL RING IN BODY
OR COVER, THEN INSTALL
CARTRIDGE KIT.

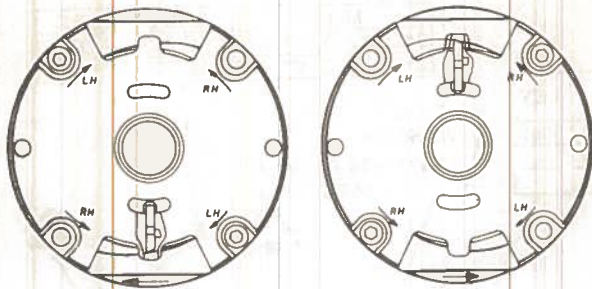
■ NOTE: FLEX SIDEPLATE KITS
INCLUDE FOUR (4) F3 SEAL PACKS

USE THE REPLACEMENT PARTS SHOWN ON
THIS DRAWING TO SERVICE A 2520V-10/12
UNIT. CARTRIDGES MUST BE REPLACED AS
A KIT. INDIVIDUAL PARTS OF A CARTRIDGE
ARE NOT INTERCHANGEABLE.

VQ REPLACEMENT
CARTRIDGES FOR
THE 2521 SERIES.



SHARP EDGE OF VANE MUST
LEAD DIRECTION OF ROTATION



* COVER END CARTRIDGE R.H. ROTATION * SHAFT END CARTRIDGE R.H. ROTATION

NOTE

* STANDARD RIGHT HAND SHAFT ROTATION
CARTRIDGES SHOWN: REVERSE FOR LEFT
HAND ROTATION.

TO REVERSE CARTRIDGE KIT ROTATION,
REMOVE THE TWO SCREWS, AND REVERSE
THE LOCATION OF THE INLET SUPPORT
PLATE AND OUTLET SUPPORT PLATE. RE-
INSTALL THE TWO SCREWS HAND TIGHT.
USE PUMP COVER TO ALIGN ALL SECTIONS
OF THE CARTRIDGE. REMOVE COVER CARE-
FULLY AND TIGHTEN SCREWS TO RECOM-
MENDED TORQUE.

MODEL CODE BREAKDOWN

(F3) 2520VQ12A11S1CC6D20L ***

SPECIAL VITON SEALS

SERIES

2520VQ DOUBLE PUMP
2620VQ DOUBLE PUMP

VANE PUMP

(INTRA-VANE FLEX PLATE TYPE)

US GPM CAPACITY - SHAFT END PUMP
(SAE RATING 1200 RPM-100 PSI)

12, 14, 17, 19, 21

SAE PORT CONNECTIONS

MODELS WITHOUT FLOW CONTROL

CODE	INLET	OUTLET NO. 1 SHAFT END	OUTLET NO. 2 COVER END
A	4-BOLT FLG.	4-BOLT FLG.	4-BOLT FLG.
C	4-BOLT FLG.	SAE ST. THD.	SAE ST. THD.
E	4-BOLT FLG.	4-BOLT FLG.	SAE ST. THD.
F	4-BOLT FLG.	SAE ST. THD.	4-BOLT FLG.

MODELS WITH FLOW CONTROL

CODE	INLET	OUTLET NO. 1	OUTLET NO. 2	TANK RETURN
C	4-BOLT FLANGE	ST. THD.	ST. THD.	ST. THD.
E	4-BOLT FLANGE	4-BOLT FLANGE	ST. THD.	ST. THD.

US GPM CAPACITY-COVER END PUMP
(SAE RATING 1200 RPM-100 PSI)

5 9 12
8 11 14

MOUNTING

F- FOOT (SINGLE SHAFT SEAL)
S- FLANGE (DOUBLE SHAFT SEAL)
OMITTED- FLANGE (SINGLE SHAFT
SEAL)

SHAFT TYPE

1- STRAIGHT KEYED
11- SPLINED
123- SPLINED

SPECIAL FEATURE

SHAFT ROTATION

(VIEWED FROM SHAFT END)
L - LEFT HAND (OMIT FOR
RIGHT HAND)

DESIGN

RELIEF VALVE SETTING-PSI

(MODELS WITH FLOW CONTROL)

C- 750 G-1750

D-1000 H-2000

E-1250 J-2250 **20V PUMP ONLY
F-1500 K-2500 } NOT FOR 12 & 14
RING SIZES

CONTROLLED FLOW RATE-GPM

(MODELS WITH FLOW CONTROL)

2, 4, 6, 7, 8, 10 OR 12 GPM

OUTLET POSITIONS VIEWED FROM COVER END

WITH #1 OUTLET OPPOSITE INLET	AA	#2 OUTLET-135° CCW FROM INLET
	AB	" " - 45° CCW FROM INLET
	AC	" " - 45° CW FROM INLET
	AD	" " -135° CW FROM INLET
WITH #1 OUTLET 90° CCW FROM INLET	BA	#2 OUTLET-135° CW FROM INLET
	BB	" " - 45° CCW FROM INLET
	BC	" " - 45° CW FROM INLET
	BD	" " -135° CW FROM INLET
WITH # 1 OUTLET INLINE WITH INLET	CA	#2 OUTLET-135° CCW FROM INLET
	CB	" " - 45° CCW FROM INLET
	CC	" " - 45° CW FROM INLET
	CD	" " -135° CW FROM INLET
WITH #1 OUTLET 90° CW FROM INLET	DA	#2 OUTLET-135° CCW FROM INLET
	DB	" " - 45° CCW FROM INLET
	DC	" " - 45° CW FROM INLET
	DD	" " -135° CW FROM INLET

To insure sustained efficiency and maximum trouble free life of this precision equipment, initial and continuous full flow filtration of the fluid medium is essential. Select and apply filters from the Vickers OFP, OFR, and OFRS series, which are available in 3, 10, and 25 micrometre filtration ratings.

Litho in U.S.A.

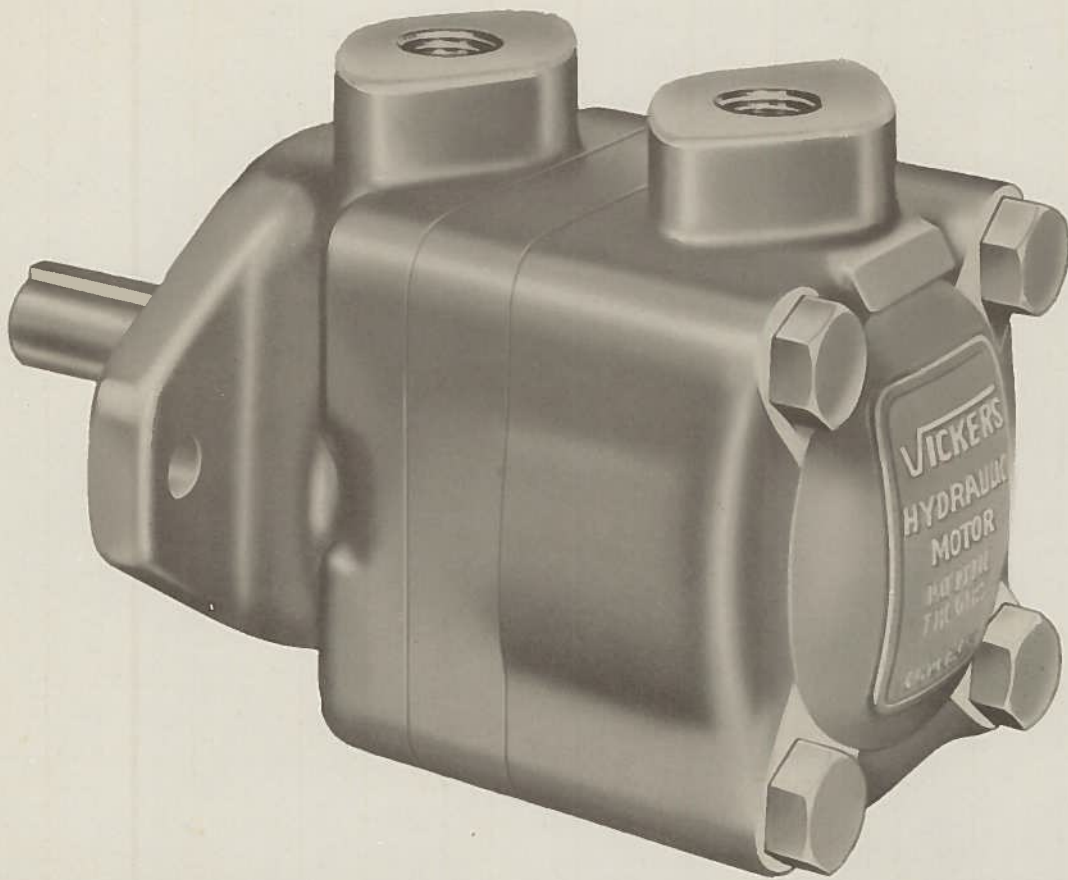
VICKERS

8

Overhaul Manual

**Vane
Motors**

M2-200, M2-300, M2-400
and M2-500 Series



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 9-1-86

M-2700-S



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SECTION I - INTRODUCTION

A. PURPOSE OF MANUAL

Service information in this manual covers the principles of operation, installation, maintenance and repair of Vickers M2 series balanced vane type hydraulic motors.

B. GENERAL INFORMATION

Service parts information and installation dimensions are contained in parts catalogs and installation drawings listed in Table I. Copies are available on request from your local Vickers Mobile Division application engineer or from Vickers Mobile Hydraulics Division, P. O. Box 302, Troy, Michigan 48084.

Table II shows a complete breakdown of the model code covering these units. Service inquiries should always include the complete model number, which can be found on the name plate.

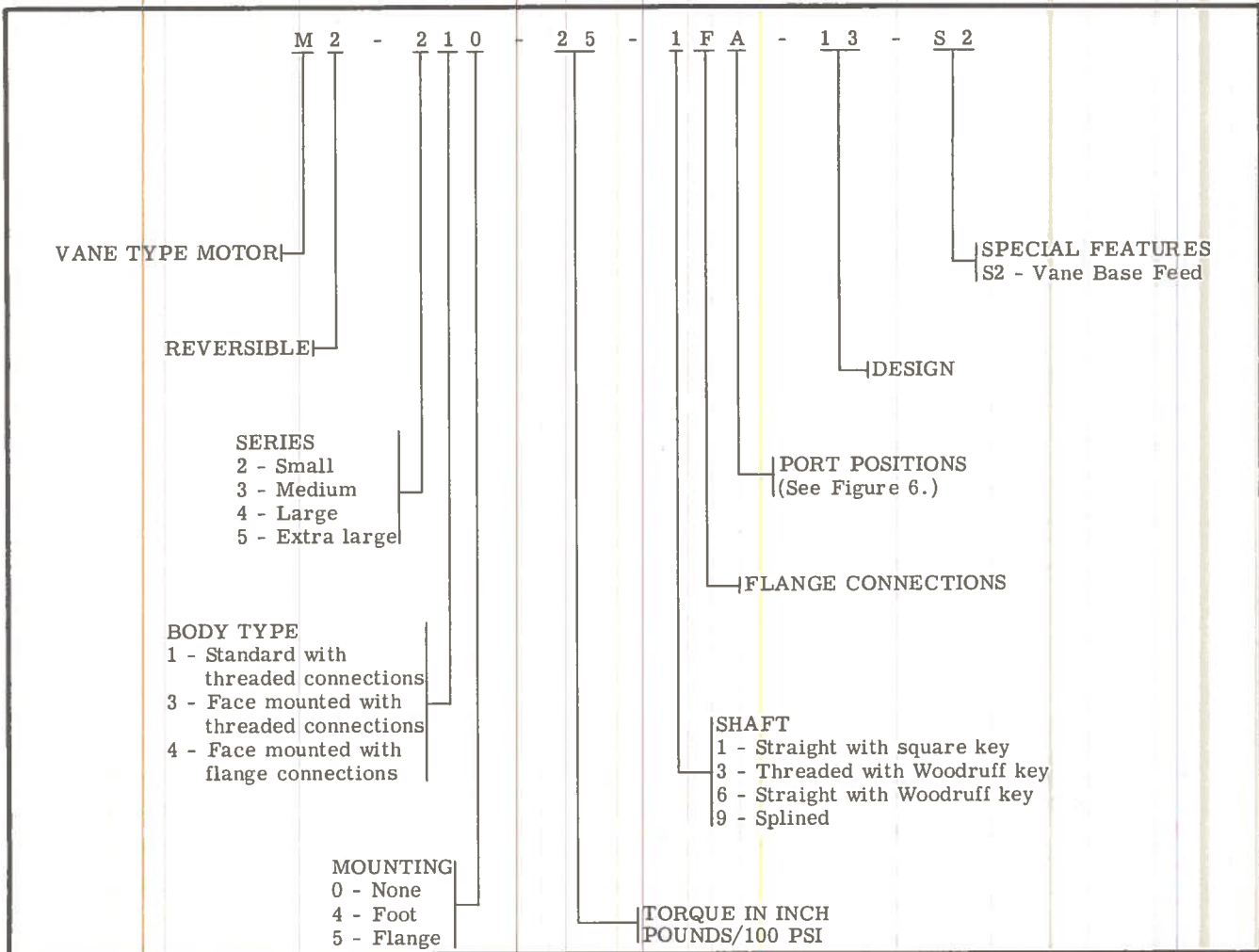
always include the complete model number, which can be found on the name plate.

Motors of the -13 design will be referred to in the discussion which follows in Sections II through VII, but information is essentially the same for the -11 and -12 designs. Section VIII describes the differences between the three designs.

TABLE I - APPLICABLE PUBLICATIONS

MODEL SERIES	INSTALLATION DRAWING	PARTS CATALOG
M2-200 Series -13	M - 273813	M-2701-S
M2-300 Series -13	M - 142085	M-2703-S
M2-400 Series -13	M - 142041	M-2705-S
M2-500 Series -13	M - 142042	M-2707-S

TABLE II - MODEL CODE BREAKDOWN



SECTION II - DESCRIPTION

A. GENERAL

All motors covered in this manual are basically identical in construction. Variables in the model numbers cover different sizes, mounting and port connections. Motors are of three basic sizes: small series M2-200, intermediate series M2-300 and large series M2-400 and M2-500. Sizes are progressively rated in torque.

Motors are designed for installation in a hydraulic circuit requiring rotary mechanical power. Their operating characteristics are of the variable horsepower class in that horsepower output is in proportion to rpm so long as operating pressure is constant. These motors can be used for reversing service and can be stalled under load without damage.

Construction is such that the output capacity can be varied (within a series) to suit the particular needs of the user. This is accomplished by changing the ring and rotor sub-assembly (Section VI).

B. ASSEMBLY AND CONSTRUCTION

Figure 1 illustrates basic motor construction. The unit consists principally of a body, cover, drive cartridge, pressure plate, drive shaft and bearings. The cartridge consists of a ring, rotor, twelve vanes and twelve rocker arms. The vanes slide radially in the rotor slots to follow the cam contour of the ring. Rocker arms hold the vanes out against the ring.

The rotor is splined to the output shaft. The shaft is supported by two bearings.

The cartridge is adjoined by the pressure plate on one side and the body on the other. The pressure plate is housed in the cover and loaded against the cartridge by a spring washer (not visible in Figure 1). The cover and body each incorporate an oil port used as system connections to direct oil to and from the motor.

Locating pins position the ring with respect to the pressure plate and body. The shaft seal prevents leakage of oil out of the system at the shaft and the entry of air into the system.

C. S2 MOTORS

These motors differ from standard units in that the vanes are held out against the ring by oil pressure. Pressure is fed in through a connection in the cover and through a special pressure plate. Rocker arms are not used.

D. MOUNTING AND DRIVE CONNECTIONS

Units can be either face or foot mounted. The rugged two bearing construction permits the motors to be used in direct or indirect drive installations.

E. APPLICATION

Vickers Mobile Hydraulics Division application engineers should be consulted for motor ratings and applications.

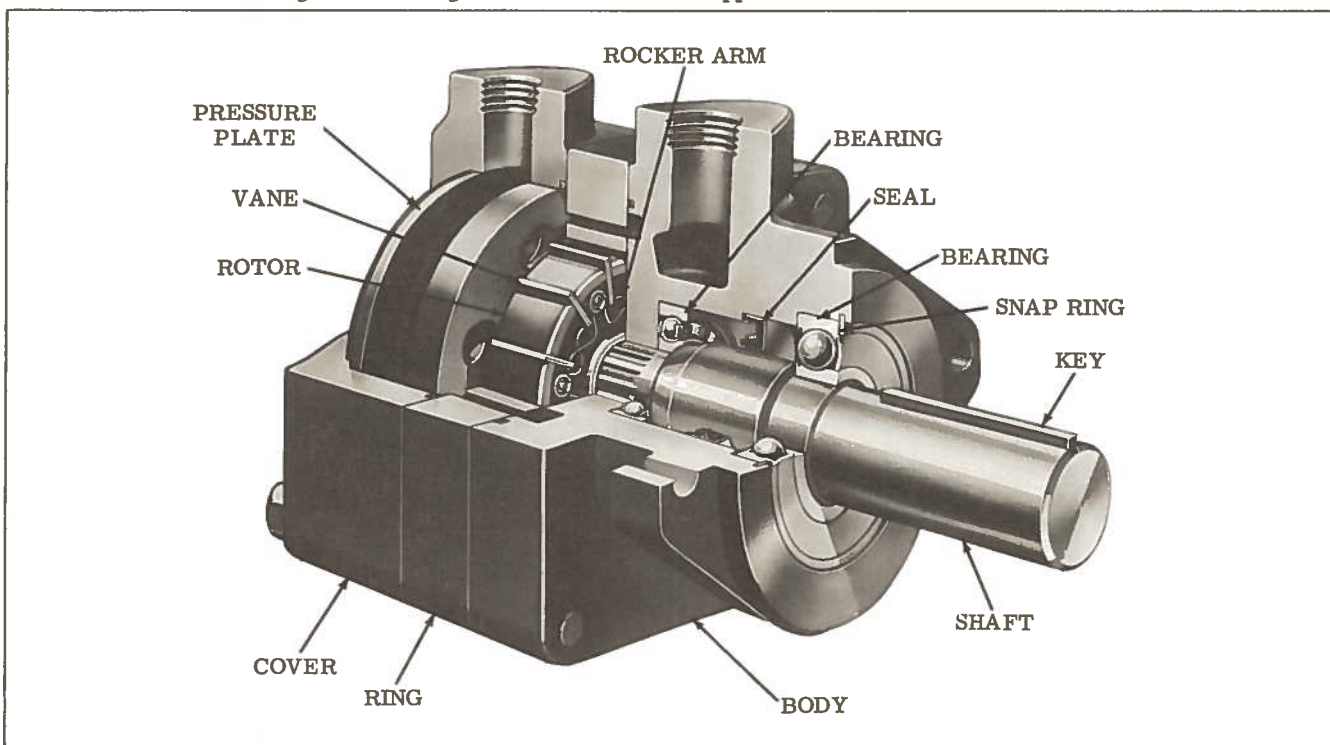


Figure 1

SECTION III - PRINCIPLES OF OPERATION

A. GENERAL

Rotation of the motor shaft is caused by fluid flow through the motor exerting a force against the vanes. This force is in effect tangential to the rotor and causes the rotor to turn, carrying the motor shaft with it.

If fluid is directed into the motor from the body port (see Figure 2), shaft rotation, as viewed from the head end is counterclockwise. When the cover port is used for the inlet, rotation is clockwise as viewed from the cover end. Changing the direction of fluid flow thus changes the direction of motor rotation. This is usually accomplished by the use of a suitable directional control valve. With either port open to pressure, the other port becomes the return port.

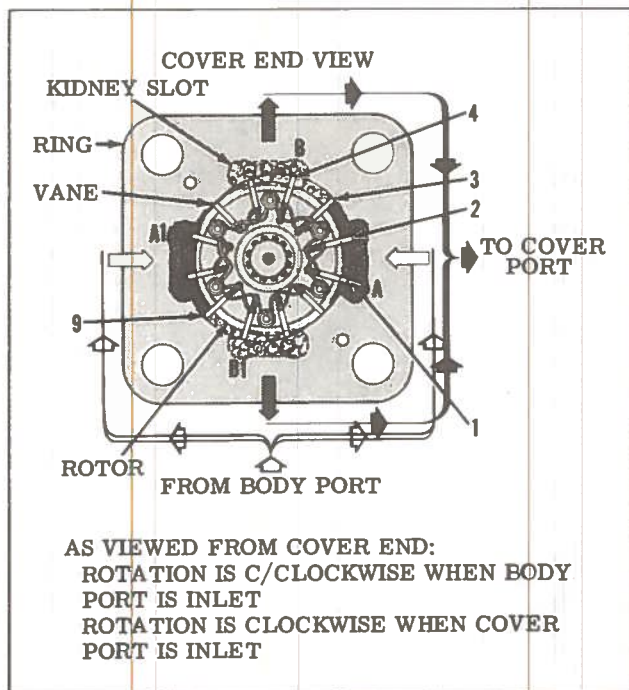


Figure 2

B. CARTRIDGE ACTION

High pressure oil entering the body port (see Figure 3) is divided by internal coring and is directed into chambers between the vanes thru kidney slots A and A1 (see Figure 2). The chamber between vane 2 and vane 3 is supplied with high pressure oil from port A. The chamber between vane 3 and vane 4 is at a lower pressure because it is open to discharge port B. Counterclockwise rotation of the rotor and vane assembly results from the difference in pressure across vane 3. This action is duplicated on vane 9.

As any two successive vanes pass the A and A1 slots, fluid between them is trapped and carried to the B and B1 slots. Here, the distance between the rotor and ring is decreasing, and the fluid flows into low pressure kidney slots and is directed through internal coring to tank.

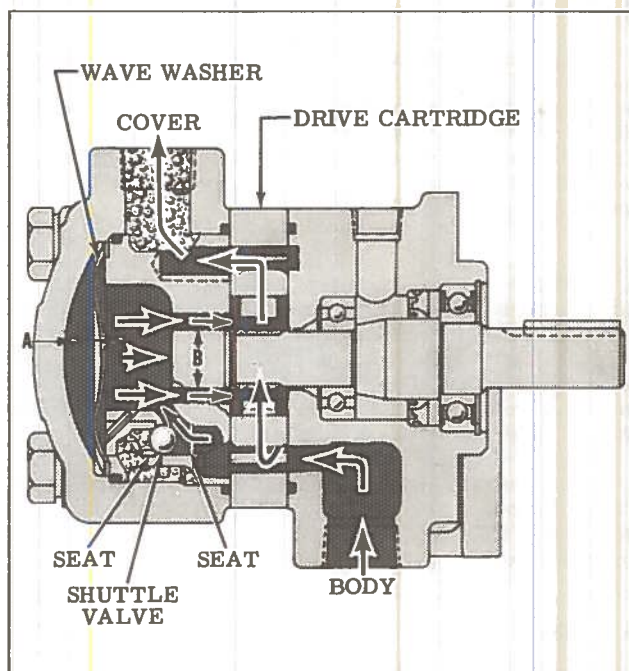


Figure 3

It can be readily seen from Figure 2 that if the direction of flow is reversed, B and B1 will become pressure chambers and the direction of shaft rotation will be reversed.

C. HYDRAULIC BALANCE

Regardless of whether A and A1 or B and B1 are high pressure chambers, equal pressure will always be present in any two chambers 180° apart. Thus, hydraulic loads against the shaft cancel each other out and the unit is in hydraulic balance.

D. ROCKER ARMS

Rocker arms (Figure 4) are required to hold the vanes outward against the ring until system pressure builds up. They also aid in keeping the vanes against the ring when the pressure is at a high level (see paragraph E - Pressure Plate, below). These arms move about a pivot pin attached to the rotor. The ends of each arm support two vanes 90° apart.

Action is such that as one vane (A) is being forced into its rotor slot by the ring, the other (B) is forced out by the rocker arm. Although the arm exerts a certain amount of spring tension against the vanes, flexing is virtually eliminated by the rocking action as the arm swivels on its pin.

E. PRESSURE PLATE

The pressure plate serves two purposes: it seals the cover end of the cartridge against internal leakage and it contains porting to feed system pressure to the base of the vanes to hold them out against the ring.

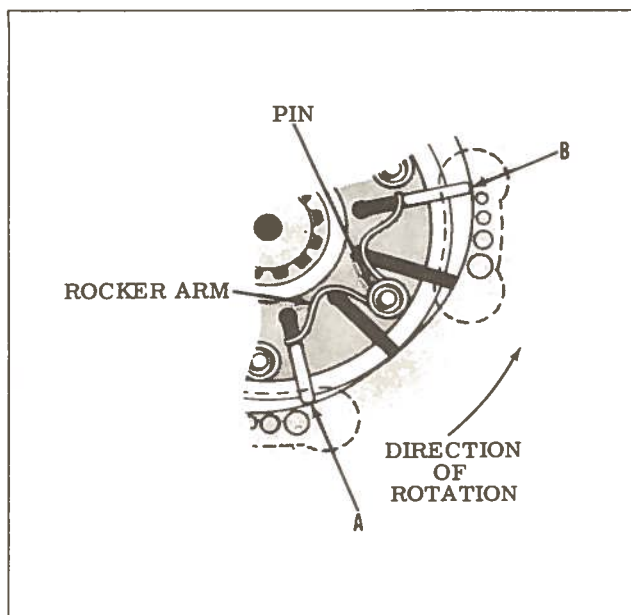


Figure 4

Before pressure builds up, the pressure plate is held against the cartridge by a wave (spring) washer (Figure 3). As system pressure builds up, shuttle valves (1 in Figure 3) in the pressure plate permit system pressure at the inlet port to act on the cover end of the pressure plate (chamber A). This provides a force necessary to overcome the axial separating forces within the rotating group. Pressure ported by these shuttle valves is also supplied to the under side of the vanes (through passage B).

The shuttle valve seals against one or the other of the seats (depending on the direction of flow) and prevents pressure fluid from escaping to the outlet port without going through the cartridge.

F. S2 MOTORS

In these motors, a pressure 30 psi higher than system pressure is continually fed to the base of the vanes and to the front of the pressure plate. This is accomplished by connecting an external pressure source to the motor cover and feeding pressure oil directly behind the pressure plate.

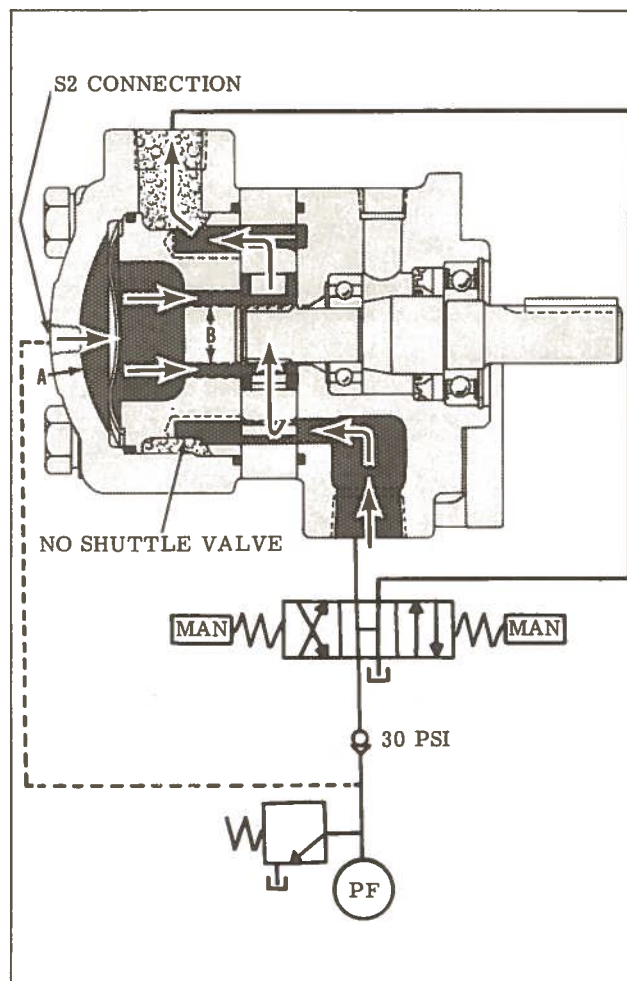


Figure 5

Rocker arms are not required, and so a pump rotor is used. The special pressure plate has porting to feed pressure under the vanes thus eliminating the need for shuttle valves (see Figure 5).

Pressure 30 psi higher than system pressure is obtained by placing a 30 psi check valve between the pump and directional valve and sampling pressure ahead of the check valve (see Figure 5).

SECTION IV - INSTALLATION AND OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS

Installation drawings listed in Table I give correct installation dimensions and instructions.

B. DRIVE CONNECTIONS

1. Direct Mounting - Motors so connected are mechanically linked by shaft couplings to the work load.

Care should be exercised in tightening all flange mounting screws to prevent misalignment of shaft connections. If gaskets are used between mounting flanges of motors and work load, they should be installed to lay flat and the same care should be taken in tightening the flange screws evenly. Shaft connecting devices that are specified for a particular motor, i.e., keys, collars, or tongued shafts, must be properly seated to avoid slippage and possible shearing of the shafts.

2. **Indirect Mounting** - Motors mounted indirectly to work load employ the use of pulleys and "V" belts or chain and/or spur gear arrangements. Because of slippage possibilities, it is not recommended that flat belts be used. It is important to check for correct alignment and excessive belt tension for any drive coupling arrangement employed on these motors. This is necessary to prevent excessive side loads imposed on the drive shaft bearings.

C. SHAFT ROTATION

Motors can be driven in either direction of rotation without changing their construction or assembly.

D. HYDRAULIC TUBING

1. The number of bends in tubing must be kept to a minimum to prevent excessive turbulence and friction of oil flow.

2. Tubing must not be bent too sharply. The minimum radius for bends is three times the inside diameter of the tube.

3. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

4. All tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sand blasting, wire brushing and pickling.

E. HYDRAULIC FLUID RECOMMENDATIONS

The oil in a hydraulic system serves as the power transmission medium. It is also the system's lubricant and coolant. Selection of the proper oil is a requirement for satisfactory system performance and life. Oil must be selected with care and with the assistance of a reputable supplier.

TWO IMPORTANT FACTORS IN SELECTING AN OIL ARE:

1. **Antiwear Additives** - The oil selected must contain the necessary additives to insure high antiwear characteristics.

2. **Viscosity** - The oil selected must have proper viscosity to maintain adequate lubricating film at system operating temperature.

SUITABLE TYPES OF OIL ARE:

1. **Crankcase Oil** meeting API service classification MS. The MS (most severe) classification is the key to proper selection of crankcase oils for Mobile hydraulic systems.

2. **Antiwear Type Hydraulic Oil** - There is no common designation for oils of this type. However, they are produced by all major oil suppliers and provide the antiwear qualities of MS crankcase oils.

3. **Certain Other Types of Petroleum Oils** are suitable for Mobile hydraulic service if they meet the following provisions:

(A) Contain the type and content of antiwear compounding found in MS crankcase oils or have passed pump tests similar to those used in developing the antiwear type hydraulic oils.

(B) Meet the viscosity recommendations shown in the following table.

(C) Have sufficient chemical stability for Mobile hydraulic system service.

The following types of oil are suitable if they meet the above three provisions:

Series 3 Diesel Engine Oil
Automatic Transmission Fluid Types A, F and DEXRON
Hydraulic Transmission Fluid Types C-1 and C-2

The following table summarizes oil types recommended for use with Vickers equipment in Mobile hydraulic system by viscosity and service classification.

TABLE III

Hydraulic System Operating Temperature Range (Min. * To Max.)	SAE Viscosity Designation	American Petroleum Institute (API) Service Classification
0° F. to 180° F.	10W	MS
0° F. to 210° F.	10W-30**	MS
50° F. to 210° F.	20-20W	MS

* Ambient Start Up Temperature

** See paragraph on Viscosity Index

OPERATING TEMPERATURE

The temperatures shown in table III are cold start-up to maximum operating. Suitable start-up procedures must be followed to insure adequate lubrication during system warm-up.

ARCTIC CONDITIONS

Arctic conditions represent a specialized field where extensive use is made of heating equipment before starting. If necessary, this, and judicious use of SAE 5W or SAE 5W-20 oil in line with the viscosity guide lines shown in the table, may be used. Dilution of SAE 10W (MS) oil with maximum of 20% by volume of kerosene or low temperature diesel fuel is permissible. During cold start-up, avoid high speed operation of hydraulic system components until the system is warmed up to provide adequate lubrication. Operating temperature should be closely monitored to avoid exceeding a temperature of 130° F. with any of these light weight or diluted oils.

OTHER FACTORS IN SELECTING AN OIL ARE:

1. **Viscosity** - Viscosity is the measure of fluidity. In addition to dynamic lubricating properties, oil must have sufficient body to provide adequate sealing effect between working parts of pumps, valves, cylinders and motors, but not enough to cause pump cavitation or sluggish valve action. Optimum operating viscosity of the oil should be between 80 SSU and 180 SSU. During sustained high temperature operation viscosity should not fall below 60 SSU.

2. **Viscosity Index** - Viscosity index reflects the way viscosity changes with temperature. The smaller the viscosity change the higher the viscosity index. The viscosity index of hydraulic system oil should not be less than 90. Multiple viscosity oils, such as SAE 10W-

30, incorporate additives to improve viscosity index (polymer thickened). Oils of this type generally exhibit both temporary and permanent decrease in viscosity due to the oil shear encountered in the operating hydraulic system. Accordingly, when such oils are selected, it is desirable to use those with high shear stability to insure that viscosity remains within recommended limits.

3. Additives - Research has developed a number of additive agents which materially improve various characteristics of oil for hydraulic systems. These additives are selected to reduce wear, increase chemical stability, inhibit corrosion and depress the pour point. The most desirable oils for hydraulic service contain higher amounts of antiwear compounding.

SPECIAL REQUIREMENTS:

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers sales representative.

CLEANLINESS:

Thorough precautions should always be observed to insure that the hydraulic system is clean:

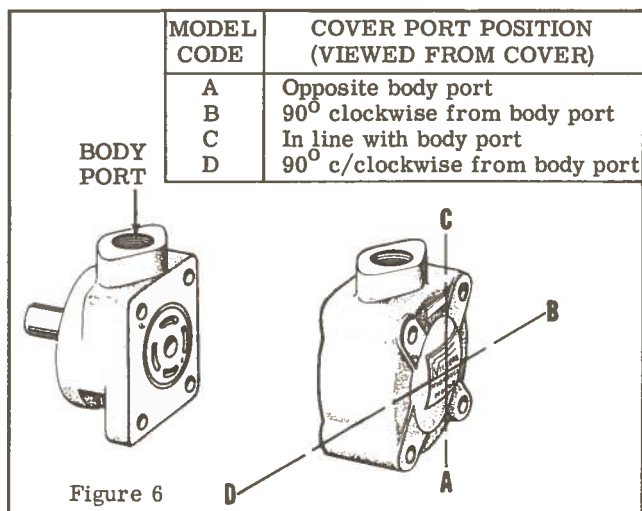
1. Clean (flush) entire system to remove paint, metal chips, welding shot, etc.
2. Filter each change of oil to prevent introduction of contaminant into the system.
3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.
4. Provide continuous protection of system from entry of airborne contamination.
5. During usage, proper oil filling and servicing of filters, breathers, reservoirs, etc., cannot be over-emphasized.

F. OVERLOAD PROTECTION

A relief valve must be installed in the system to protect components from excessive pressure. The setting of the relief valve depends on the work requirements of the system and the maximum pressure ratings of system components.

G. PORT POSITIONS

Covers can be assembled in four positions with respect to bodies as shown in Figure 6. To change the relative location of the ports, it is necessary only to remove the four cover bolts and rotate the cover to the desired position. Cover bolts must be tightened to the torque specified in Figure 7 at reassembly.



SECTION V - SERVICE INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

No special tools are required to service these units.

B. INSPECTION

Periodic inspection of oil condition and tubing connections can save time consuming breakdowns and unnecessary parts replacement.

1. All hydraulic connections must be tight. Loose connections will permit air to be drawn into the system causing noisy and erratic operation, or will permit the hydraulic fluid to leak out.

2. The system filters and reservoir should be checked for contamination. Dirty filters must be replaced. If the oil is contaminated, the system should be thoroughly drained and the reservoir cleaned before adding new oil.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a micron filter. If such a filter is not available, a funnel with a fine wire screen (200 mesh or better) can be used.

It is important that oil be clean and free of all substance which will cause improper operation and excessive wear of any unit in the system.

D. LUBRICATION

Internal lubrication is provided by system oil flow.

E. REPLACEMENT PARTS

Only genuine parts manufactured or sold by Vickers Incorporated should be used as replacement parts for these motors. They are shown in the parts catalogs listed in Table I. Copies are available on request.

F. TROUBLE SHOOTING

Table IV lists the difficulties which may be experienced with the unit and hydraulic system. It indicates the cause and remedy for each of the troubles listed. It should always be remembered that pressure and delivery are factors which are usually dependent upon each other. Adequate pressure gage equipment and a thorough understanding of the operation of the complete hydraulic system are essential to diagnose improper operation.

TABLE IV - TROUBLE, CAUSE AND REMEDY CHART

TROUBLE	PROBABLE CAUSE	REMEDY
MOTOR NOT DEVELOPING SUFFICIENT SPEED OR POWER	Insufficient fluid pressure.	Check delivery of pump. Make certain sufficient hydraulic fluid is available to pump. Check pump drive speed.
	System overload relief valve not set at correct pressure.	Check pressure and reset relief valve.
	Driven mechanism requiring excessive torque.	Remove motor and check torque requirements of driven shaft.
	Parts of motor cartridge scored by foreign matter in oil.	Remove motor for overhaul.
MOTOR SHAFT CONTINUING TO ROTATE WHEN CONTROL IS IN "OFF" POSITION	Control valve not functioning properly.	Check control valve for spool and leakage.
MOTOR TURNING IN WRONG DIRECTION	Improper connections at valve plate.	Reverse port connections.
	Pump or other component in system not functioning as intended.	Check complete system for proper operation. Determine proper direction of pump drive.

SECTION VI - OVERHAUL

A. GENERAL

All components removed from the system must be plugged and lines must be capped to prevent entry of dirt in the system. During disassembly, particular attention should be given to the identification of parts for reassembly.

Figure 7 is an exploded view showing the proper relationship of parts for disassembly and assembly. Figure 1 can be referred to for the correct assembled relationship of parts.

B. DISASSEMBLY

Be certain the unit is not subjected to pressure. Disconnect and cap all lines before removing the motor from its mounting. Remove the flanges, screws and "O" rings from M2-500 series motors.

1. Cover End - Place the motor on blocks cover end up. Remove the four cover screws and washers and lift off the cover.

Remove the "O" ring from the groove in the cover. Remove the pressure plate and wave washer from the cover and remove the "O" ring from the pressure plate. Do not disassemble the shuttle valves unless it is necessary to replace them because of leakage.

Lift off the ring and locating pins. Remove the vanes and rotor sub-assembly.

2. Shaft End - Remove the shaft key and foot mounting (if used). Remove the snap ring from the body and tap the cover end of the shaft to force out the shaft and front bearing. If it is necessary to remove the bearing from the shaft, support the inner race in an arbor press while pressing the shaft out.

Remove the oil seal and tap out the inner bearing by inserting a punch in the cover end of the body.

C. INSPECTION AND REPAIR

1. Discard the used oil seal and "O" rings. Clean all parts in mineral oil solvent and place them on a clean surface for inspection.

2. Check the wearing surfaces of the body, pressure plate, ring and rotor for scoring and excessive wear. Remove light scoring by lapping. Replace heavily scored parts.

3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Check that vanes do not stick in the rotor slots. They should move from their own weight when both rotor and vanes are dry. Replace any defective vanes.

TORQUE (FT. LBS.)	MODEL SERIES
70 ± 5	M2-200
100 ± 10	M2-300
150 ± 10	M2-400
250 ± 10	M2-500

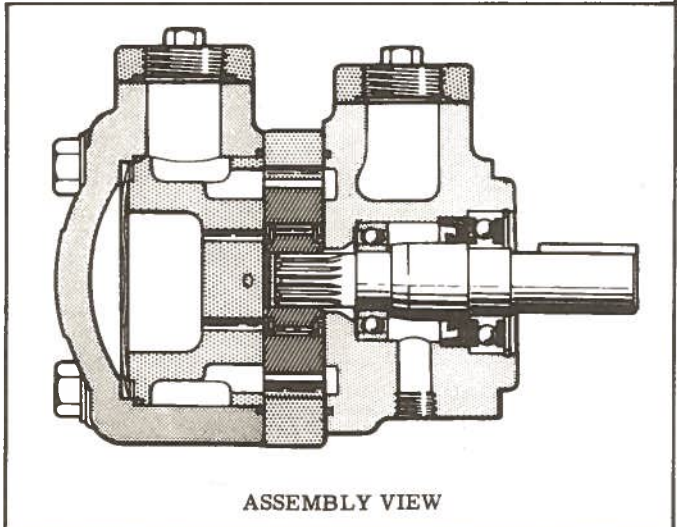
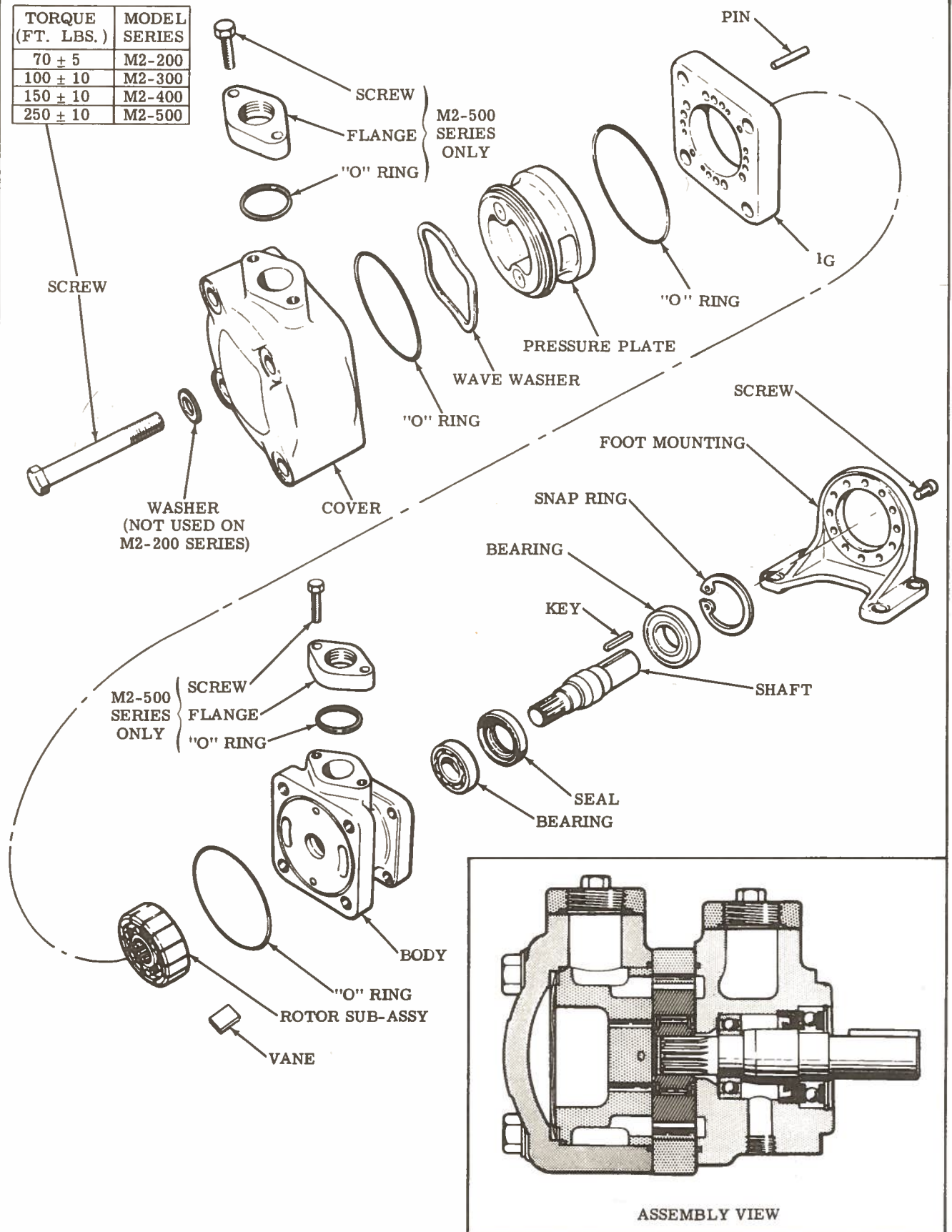


Figure 7

4. Check the bearings for wear and looseness. Rotate the bearings, applying pressure to the outer race, to check for pitted or cracked races.

5. Inspect the oil seal journal on the shaft for scoring or wear. Replace the shaft if marks cannot be removed by light lapping.

6. Inspect vane rocker arms for wear and loss of tension. Replace the rotor sub-assembly if rocker arms are defective.

D. REASSEMBLY

Coat all parts with clean hydraulic oil to facilitate reassembly and provide initial lubrication.

1. Shaft End - Place the body on a block, shaft end up. With a driver which contacts the outer race only, seat the inner bearing in the body.

Press the shaft seal into the body with the sealing lip facing the cover end. Use a driver which will apply force only near the seal periphery. Be certain the seal is firmly in place and is not cocked.

Press the outer bearing onto the shaft while supporting the inner race. Cover the shaft splines with tape or a bullet and install the shaft. The outer bearing must seal firmly in the body. Install the snapring which retains the shaft and bearing. If a mounting bracket is used, it can be installed now. Tighten the screws evenly to prevent cocking. Install the shaft key.

2. Cover End - Place the unit on blocks, shaft end down. Install the "O" ring in the groove in the body. Insert both locating pins in the body face. Place the ring on a clean smooth surface and insert the rotor inside the ring. Insert the vanes into the rotor slots, being sure the rocker arm is properly located behind each individual vane on both sides of the rotor. The ring, rotor and vanes are now installed on the locating pins.

NOTE

On -13 design models, pin location makes it impossible to assemble the ring incorrectly.

When installing the vanes, be certain they rest squarely in the slots and not on the rocker arms. Check this by turning the shaft by hand and noting whether any vane extends beyond the side of the rotor.

Position the pressure plate on the locating pins and install the pressure plate "O" ring and the wave washer. Install the "O" ring in the cover and carefully place the cover over the plate and wave washer against the ring. Be sure the washer and "O" ring are not dislocated. Slowly rotate the cover to its correct position with relation to the body (see Figure 6). Install the cover screws and washers and tighten them to the torque shown in Figure 7. Turn the shaft by hand to be certain there is no binding.

SECTION VII - TESTING OF VANE MOTORS

Vickers Mobile Division application engineering personnel should be consulted for test stand circuit requirements and construction. If test equipment is

available, the motor should be tested at recommended speeds and pressures shown on installation drawings (see Table I).

SECTION VIII - DESIGN CHANGES

A. CHANGE FROM -11 TO -12 DESIGN

Changes between the -11 and -12 designs were made to improve pressure distribution (hydraulic balance) in the motor, strengthen the pressure plate and rocker arms, permit reversal of the motor without reversing the ring and improve retention of the rocker arms. Parts involved in the change were the pressure plate

sub-assembly, rotor sub-assembly and ring and, in some cases, the body and cover (see Table V).

Parts are interchangeable between the -11 and -12 design. Customers who wish to incorporate the improved parts in -11 design motors can do so without concern.

B. CHANGE FROM -12 TO -13 DESIGN

This change increased the size of flow passages and added eight overpass holes in the ring (see Figure 8). Also, the ring locating pins were moved 45°. This

makes it impossible to assemble the ring incorrectly.

Parts involved in the change are listed in Table V. Pressure plates, rings and bodies are not interchangeable (except as a group) because of the pin location. All other parts are interchangeable.

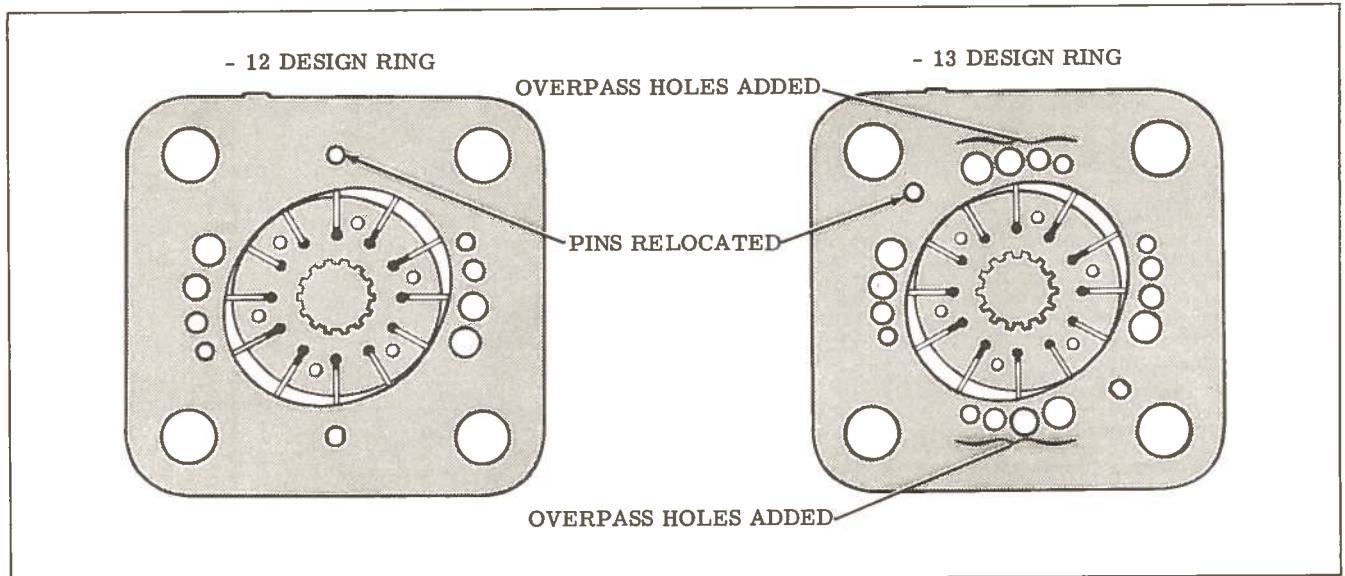


Figure 8

TABLE V - CONVERSION DATA

SERIES	NOMENCLATURE	DESIGN		
		-11	-12	-13
M2-200	Cover	137569	153998	153998
	Press Plate Sub-Assy	137570	153570	168450
	Ring 25	137576	153766	168419
	Ring 35	160795	153765	168418
	Rotor Sub-Assy 25	137573	168439	168439
	Rotor Sub-Assy 35	137573	168440	168440
	Body	127225	153698	168417
M2-300	Cover	137696	137696	137696
	Press Plate Sub-Assy	137690	153767	172412
	Ring 45	126023	153774	172410
	Ring 60	126024	153773	172409
	Ring 75	126025	153772	172411
	Rotor Sub-Assy 45	137689	170402	170402
	Rotor Sub-Assy 60	137689	170405	170405
	Rotor Sub-Assy 75	137689	170405	170405
	Body	137693	153761	172407
M2-400	Cover	138110	138110	138110
	Press Plate Sub-Assy	138108	153778	172467
	Ring 90	128553	153775	172469
	Ring 115	126507	153776	172470
	Rotor 90	170404	170404	170404
	Rotor 115	170403	170403	170403
	Body	138111	153760	172465
M2-500	Vane Kit	912030	912105	912105
	Cover	137281	137281	137281
	Press Plate	137420	153783	168601
	Ring 150	115768	153784	168596
	Ring 200	152381	153785	168597
	Rotor 150	137325	168598	168598
	Rotor 200	137325	168599	168599
	Body	126676	153790	168595
	Pin	39780	39780	187259

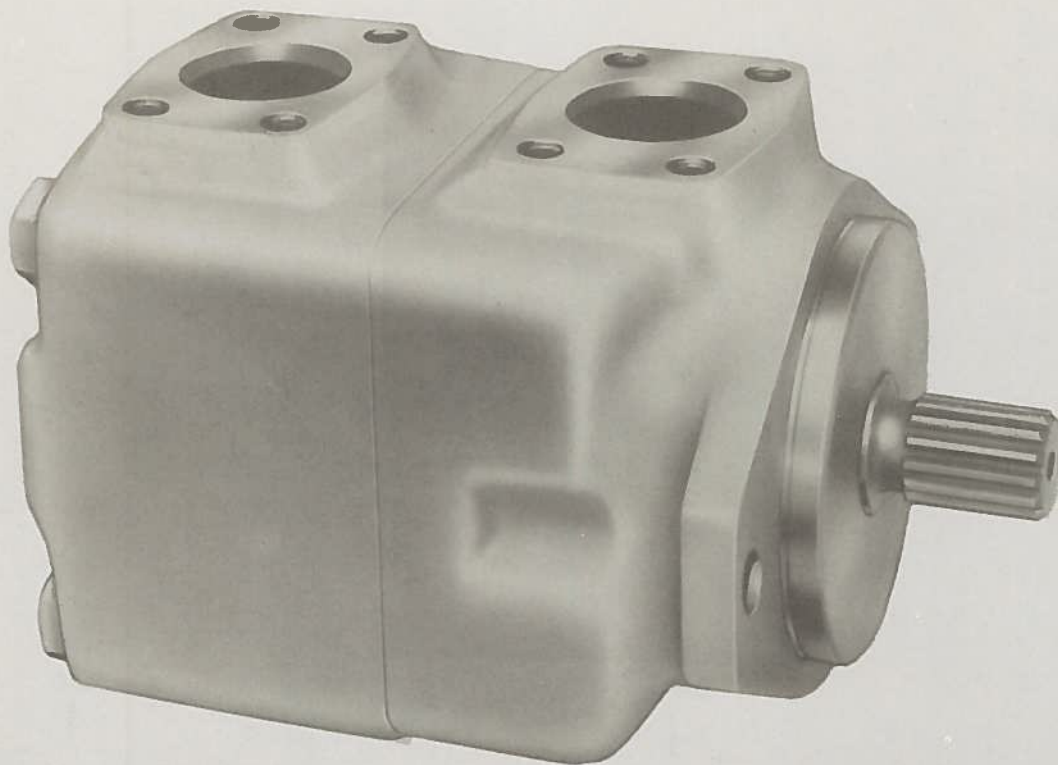
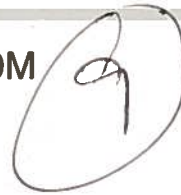


VICKERS

Overhaul Manual

**Vane
Motors**

25M, 35M, 45M, & 50M
Series -20 Design



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 5-1-86

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SECTION I - INTRODUCTION

A. PURPOSE OF MANUAL

This manual has been prepared to assist the users of Vickers high-performance vane motors in properly installing, maintaining and repairing their units. The vane motors are described in detail and their theory of operation is discussed. In addition, instructions are given for installation, maintenance and overhaul.

The general series of models covered are 25M, 26M, 35M, 36M, 45M, 46M, 50M and 51M. The information given applies to the latest design series listed in Table II. Earlier designs are covered only insofar as they are similar to present equipment.

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts catalogs and installation drawings listed in Table I are available from any Vickers Mobile Division sales office.

2. Model Codes - There are many variations within each basic model series which are covered by variables in the model code. Table II is a complete breakdown of the codes covering these units. Service inquiries should always include the complete unit model number, which is stamped on the cover.

TABLE I - PARTS CATALOGS AND INSTALLATION DRAWINGS

MODEL SERIES	PARTS CATALOGS	INSTALLATION DRAWINGS
25M, 26M-20 35M, 36M-20 45M, 46M-20 50M, 51M-20	M-2741-S M-2742-S M-2743-S M-2744-S	MB-185

TABLE II - MODEL CODE BREAKDOWN

45 M 185 A 2 - 11 C 20 *		SPECIAL FEATURES	
SERIES DESIGNATION		DESIGN NUMBER DESIGN NUMBERS SUBJECT TO CHANGE. INSTALLATION DIMENSIONS REMAIN THE SAME FOR DESIGN NUMBERS 20 THRU 29	
25 = STANDARD BEARING 26 = HEAVY DUTY BEARING 35 = STANDARD BEARING 36 = HEAVY DUTY BEARING 45 = STANDARD BEARING 46 = HEAVY DUTY BEARING 50 = STANDARD BEARING 51 = HEAVY DUTY BEARING		COVER POSITION - VIEWED FROM COVER END A = COVER PORT OPPOSITE BODY PORT B = COVER PORT 90° COUNTERCLOCKWISE FROM BODY PORT C = PORT CONNECTIONS IN LINE D = COVER PORT 90° CLOCKWISE FROM BODY PORT	
VANE MOTOR (EXTERNALLY DRAINED)		SHAFT TYPE 1 = STRAIGHT KEYED 11 = SPLINED	
RING SIZE - NOMINAL TORQUE RATING - lb. in. /100 PSI		FOOT BRACKET MOUNT AND POSITION- LEAVE BLANK IF FOOT BRACKET MOUNT NOT REQUIRED (BODY VIEWED FROM SHAFT END WITH RESPECT TO FOOT BRACKET) 2 = BODY PORT AT 12 O'CLOCK POSITION 3 = BODY PORT AT 3 O'CLOCK POSITION 6 = BODY PORT AT 6 O'CLOCK POSITION 9 = BODY PORT AT 9 O'CLOCK POSITION	
25M MOTORS 30 lb. in. 42 lb. in. 55 lb. in. 65 lb. in.		MOUNTING FLANGE AND PORT CONNECTIONS A - SAE TYPE 2-BOLT MOUNTING FLANGE AND SAE 4-BOLT FLANGED PORT CONNECTIONS.	
35M MOTORS 80 lb. in. 95 lb. in. 115 lb. in.			
45M MOTORS 130 lb. in. 155 lb. in. 185 lb. in.			
50M MOTORS 220 lb. in. 255 lb. in. 300 lb. in.			

SECTION II - DESCRIPTION

A. GENERAL

Vickers high performance vane motors, when properly installed in a hydraulic circuit, convert hydraulic power into rotary mechanical power. They are positive-displacement, balanced-cartridge units, with drive speed dependent on the motor size and gpm delivery to the inlet port. The units are capable of operating at high speeds and high pressures, or higher speeds at lower pressures. These motors may be operated in either direction of rotation, reversed or stalled under load conditions without damage.

All motors covered in this manual are basically identical in construction. The motors are designed so that the maximum torque capability can be changed within a series by changing the cartridge or the cam ring.

B. ASSEMBLY AND CONSTRUCTION

Basic motor construction is illustrated in figure 1. The unit consists principally of a body, cover, drive cartridge and shaft. Rotary motion is developed in the cartridge, which principally consists of a ring, rotor, ten vanes and two pressure plates. The rotor is splined and mates with the output shaft, which is supported by a ball bearing in the body and a bushing bearing in the cover pressure plate.

The vanes slide radially in the rotor slots and follow the elliptical cam contour of the ring as the rotor turns. These vanes are held against the ring by a combination of spring and centrifugal forces.

Port connections are located in the body and cover. Direction of shaft rotation is governed by the direction of fluid flow through these ports. Pressure is sealed from one port to the other by a teflon sealing ring in the body on the periphery of the ring. Drainage is ported through an external connection in the cover.

The cartridge is bolted together and can be serviced as a complete assembly. Locating pins position the ring with respect to the pressure plates, and in like manner, two torque pins position the cartridge in the cover. The cover can be assembled in four positions with respect to the body. Changing of the port positions is accomplished by rotating the cover and cartridge.

C. MOUNTING

The motors are body face mounted, or are available with an optional foot mounting (see section IV). The body mounting is a standard SAE 2-bolt type.

D. APPLICATIONS

Vickers high-performance vane motors are rated in pound-inches of torque per 100 psi. Horsepower output is proportional to drive speed so long as pressure is constant. For application information, refer to the appropriate sales installation drawing (Table I) or consult Vickers Mobile Division application engineering personnel.

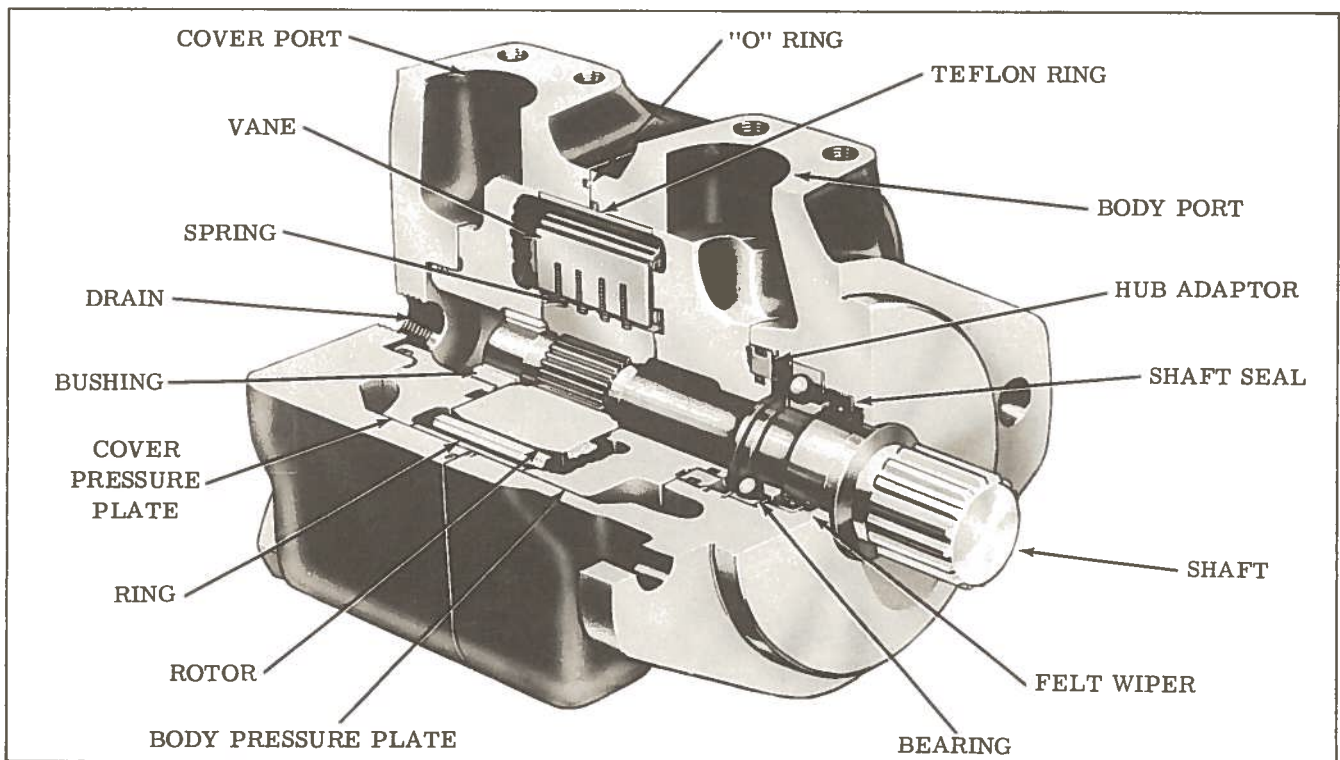


Figure 1

SECTION III - PRINCIPLES OF OPERATION

A. GENERAL

Rotation of the motor shaft is caused by differential pressure across the motor exerting a force against the vanes. This force is in effect tangential to the rotor and causes the rotor to turn, carrying the motor shaft with it.

If fluid is directed into the motor thru the body port (see figure 2), shaft rotation, as viewed from the shaft end, is clockwise. When the oil supply is directed to the cover port, rotation is counterclockwise, as viewed from the shaft end. Changing the direction of fluid flow thus changes the direction of motor rotation. This is usually accomplished by the use of a suitable directional control valve. With either port open to pressure, the other port becomes the return port.

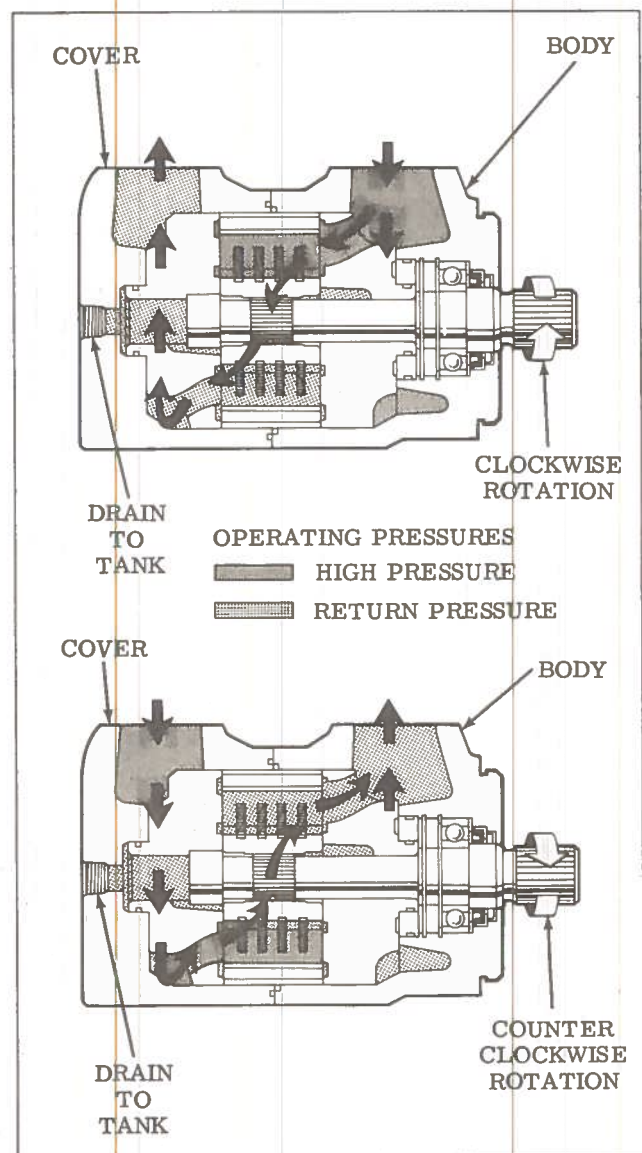


Figure 2

B. CARTRIDGE ACTION

Oil entering the inlet port (see figure 2) is divided by internal coring and is directed into chambers between the vanes thru kidney slots A and A1 (see figure 3). The chambers between vane 1 and vane 3 are supplied with high-pressure oil from ports A and A1. The chambers between vane 3 and vane 5 are at a lower pressure because they are open to discharge ports B and B1 which are connected to the tank. This clockwise rotation of the rotor and vane assembly results from the difference in pressure across vane 3. The maximum pressure in ports A and A1 is a function of the load the motor must turn. It can be readily seen from figure 3 that if the direction of flow is reversed, B and B1 will become pressure chambers and the direction of shaft rotation will be reversed.

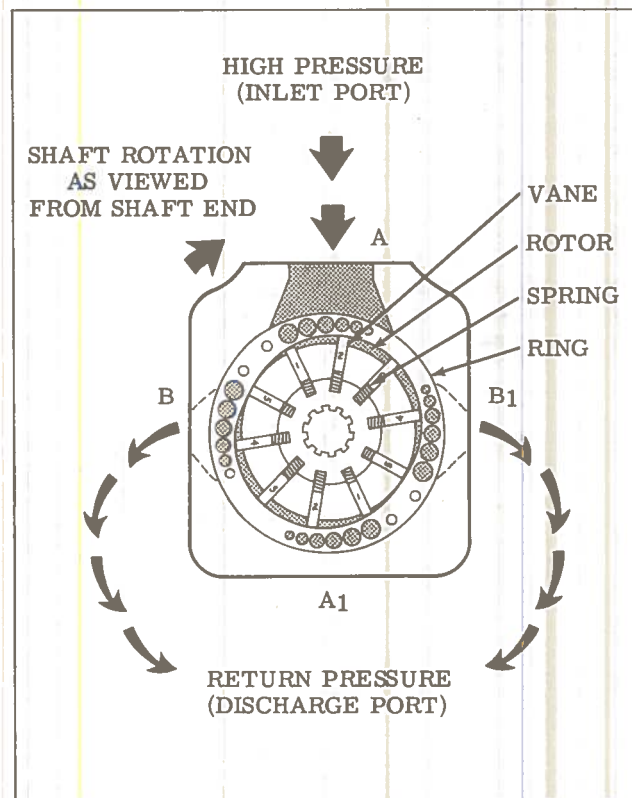


Figure 3

C. HYDRAULIC BALANCE

Regardless of whether A and A1 or B and B1 are high-pressure chambers, equal pressure will always be present in any two chambers 180 degrees apart. Thus, hydraulic loads against the shaft cancel each other out and the unit is in hydraulic balance.

D. VANE BALANCE

The vanes are ported through radial holes so that pressure at the outer edges which are against the ring is essentially equal to the inner edges. Thus, the vanes are balanced hydraulically and are held out against the ring by a combination of spring and centrifugal forces.

E. DUAL-ALTERNATE PRESSURE PLATES

The cartridge side plates used in these motors are an exclusive dual-alternate pressure plate design. Refer to figure 4.

Two basically identical plates are used. The plate subjected to high pressure functions as the pressure plate. High pressure acting on the outer annulus of this plate moves the complete cartridge--ring, rotor, and both plates--axially away from the high-pressure housing causing the cartridge to seat against the low-pressure housing (points "B" in figure 4). Construction of the plates is such that the lower pressurized plate contacts its housing on an annulus close to the axis of rotation.

Since the periphery of the low-pressure plate is not restrained from further movement, a load applied through the ring deflects it in the direction of the hydraulic load (points "A"). This action deflects that portion of the plate near the rotating axis inward towards the rotor face (points "B"). Thus, one side plate is deflected towards the rotor by high system pressure; the other plate is deflected towards the

rotor as a result of peripheral mechanical loading plus the restraining action near its center.

This design concept results in low leakage rates and high operating efficiency. Also inherent in this design is the elimination of the shuttle valve arrangement found in conventional, dual-directional vane motors.

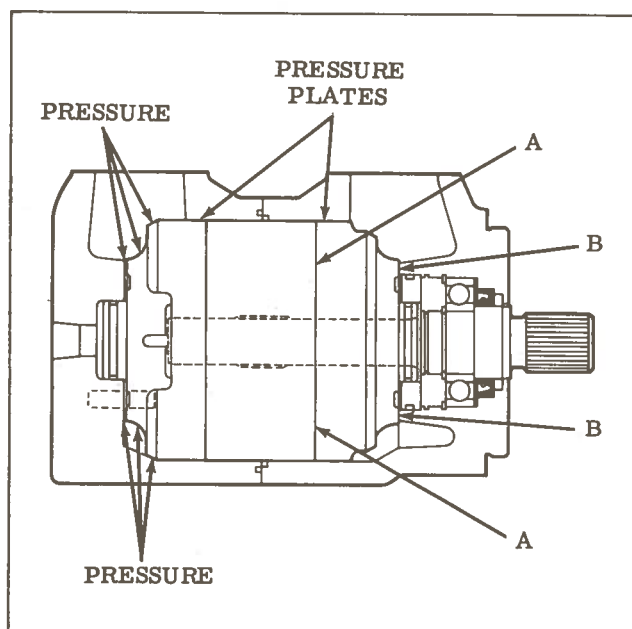


Figure 4

SECTION IV - INSTALLATION AND OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS

The installation drawings listed in Table I show the installation dimensions and port locations.

B. MOUNTING AND DRIVE CONNECTIONS

CAUTION

Vickers motor shafts are designed to be installed in flexible couplings with a slip fit or very light press. Pounding a coupling end onto the shaft can damage the bearings. Shaft tolerances are shown on the installation drawings. (See Table I.)

1. Direct Drive - A pilot on the mounting flange (figure 5) assures correct mounting and shaft alignment, provided the pilot is firmly seated in the accessory pad. Care should be exercised in tightening all flange mounting screws to prevent misalignment. This mounting is a standard SAE 2-bolt type. If gaskets are used between flanges, they should be installed carefully so as to lie flat. Shaft keys and couplings must be properly seated to avoid slipping and possible shearings. Proper coupling alignment is essential to long life.

2. Indirect Drive - Belt, chain and gear drives can be used with certain models of these motors. Specific recommendations and data on limitations should be obtained through the Vickers sales representative.

C. SHAFT ROTATION AND DRIVE SPEEDS

Motors can be driven in either direction of rotation without changing their construction or assembly.

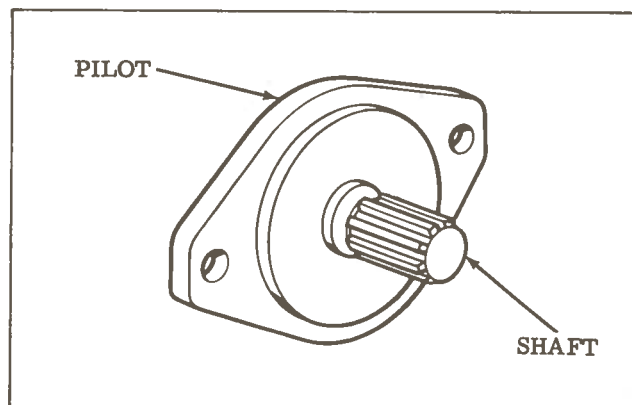


Figure 5

Normal operating speed can be as low as 50 to 100 rpm. Lower drive speeds depend on torque requirements and characteristics of the driven load. For operation below 50 rpm, consult Vickers sales representatives.

D. PIPING AND TUBING

1. All pipes, fittings, hose and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sand blasting, wire brushing and pickling.

NOTE

For instructions on pickling refer to Vickers instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

3. The number of bends in hydraulic lines should be kept to a minimum to prevent excessive turbulence and friction of oil flow and to minimize pressure drop in the lines. Tubing must not be bent too sharply. The generally accepted minimum radius for bends is three times the inside diameter of the tube.

E. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components with particular emphasis on hydraulic motors. Any oil acceptable for use with motors is acceptable for use with valves or pumps.

Data sheets for oil selection are available. For Mobile applications, order data sheet M-2950-S.

The oil recommendations noted in the data sheet are based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Sperry Vickers representative.

CLEANLINESS

To insure the hydraulic system is clean:

1. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.
2. Filter each change of oil to prevent introduction of contaminants into the system.

SOUND LEVEL

Noise is indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at start-up temperatures can cause pump noises due to cavitation.

2. Running with a moderately high viscosity fluid will slow the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir and air will be recycled through the system.

3. Aerated fluid can also be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

4. Contaminated fluids can cause excessive wear of internal pump parts, which may result in increased sound levels.

3. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

4. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.

5. Proper oil filling and servicing of filters, breathers, reservoirs, etc., cannot be overemphasized.

6. Good system and reservoir design will insure that aeration of the oil is kept to a minimum.

F. OVERLOAD PROTECTION

A relief valve must be installed in the system to limit pressure to a prescribed maximum. This protects the system components from excessive pressure. The setting of the relief valve depends on the work requirements of the system and the maximum pressure ratings of the system components. The relief protection must be designed to prevent any hydraulic surge pressure, whether applied to or generated by the motor, from exceeding the maximum pressure rating of the motor.

In the event of an overrunning load, the motor may be driven as a pump. If such a condition occurs, provision must be made in the circuit to supply the motor enough hydraulic fluid to prevent cavitation.

G. DRAIN CONNECTION

Drain passages are provided in the motor to carry internal leakage to a drain port in the cover. Never operate the motor unless the drain port is connected to the reservoir. Pressure in the drain line must not be more than 30 psi to avoid internal damage.

H. PORT POSITIONS

Covers can be assembled in four positions with respect to bodies, as shown in figure 6. To change the relative location of the ports, it is necessary only to remove the four cover bolts and rotate the cover to the desired position. Cover bolts must be tightened to the torque specified in figure 10 at reassembly.

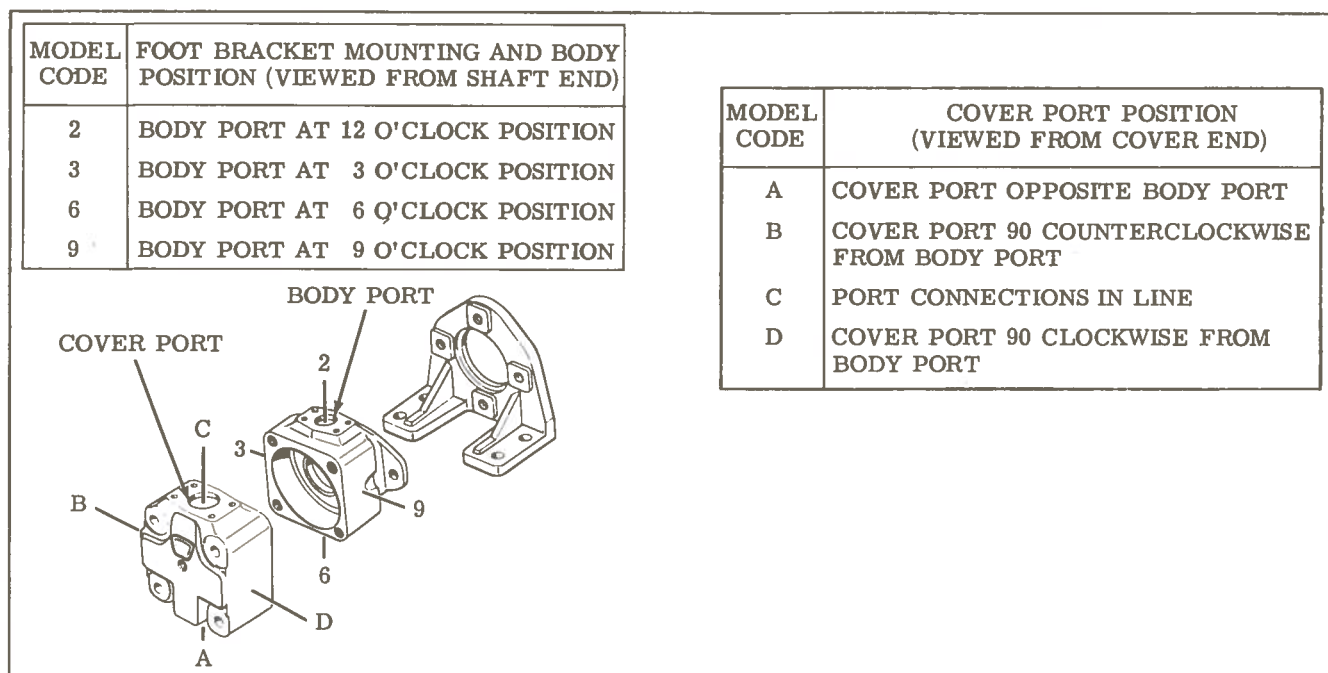


Figure 6

SECTION V - SERVICE, INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

Special tools required for these units are shaft seal drivers and adapter extractor tool. The seal drivers can be made from round stock machined as shown in figure 7.

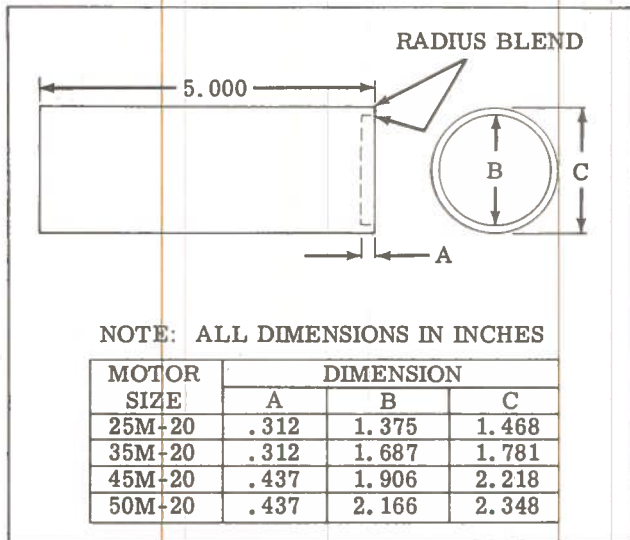


Figure 7

The recess in the tool will be deep enough so uniform pressure is applied to the recessed area in the seal channel rather than on the seal lip. The outside diameter of the tool will not interfere with the spring around the seal lip.

The adapter extractor tool is designed to remove the hub adapter from the body after the cartridge is removed (see figure 8). The extractor tool engages between the ball bearing and the hub adapter.

B. INSPECTION

Periodic inspection of oil condition and tubing

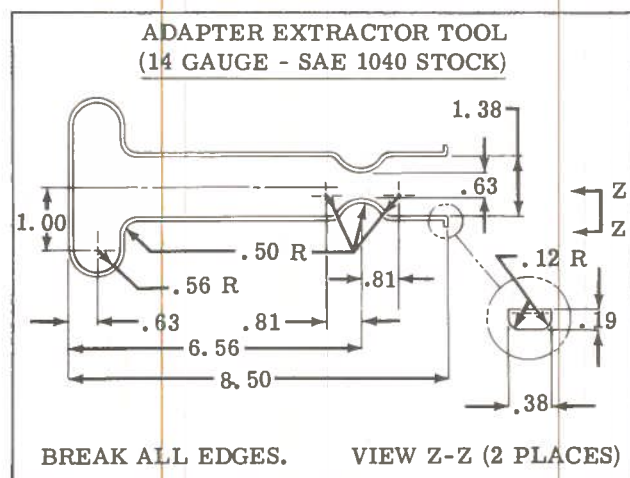


Figure 8

connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly:

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. Loose connections in other lines can permit air to be drawn into the systems, resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt, metal particles and other contaminants. If the fluid becomes contaminated the system should be thoroughly drained and the reservoir cleaned before new fluid is added.

3. Filter elements should also be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in a partial or complete loss of filtration.

4. Air bubbles in the reservoir can be harmful to the motor and other components. If bubbles are seen, the air source should be found and eliminated.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen - 200 mesh or finer. It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint from entering the system.

D. LUBRICATION AND ADJUSTMENT

Internal lubrication is provided by system oil flow. No adjustments are required other than maintaining shaft alignment.

E. REPLACEMENT PARTS

Only genuine parts manufactured or sold by Vickers Division should be used as replacement parts for these motors. They are shown in the parts catalogs listed in Table I. Copies are available on request.

F. TROUBLESHOOTING

Table IV lists possible difficulties experienced with vane motors and hydraulic systems. It also indicates the probable cause and remedies for each of the troubles listed.

It should always be remembered that failures can also be due to improper installation, inadequate maintenance and other system component malfunctions. A thorough understanding of the system and its components is important for reliable troubleshooting.

TABLE IV - TROUBLE, CAUSE AND REMEDY CHART

TROUBLE	PROBABLE CAUSE	REMEDY
MOTOR FAILS TO START	System leakage - loose port connections or broken lines.	Inspect and tighten port connections and lines.
	No fluid - inadequate fluid supply at inlet or in system.	Check fluid level in reservoir. Replenish as necessary.
	System return line or drain line restricted.	Check drain filter. Clean and/or replace filter element.
	System inlet line restricted.	Check all strainers and filter for dirt and sludge. Clean if necessary.
	Fluid viscosity too heavy to pick up prime.	Completely drain the system. Add new filtered fluid of proper viscosity.
	Air in system.	Tighten any loose connections. Bleed air from highest point in system and replenish fluid.
	Drive train damaged.	Check and repair drive train.
	Pump driven in wrong direction.	Drive direction must be reversed immediately to prevent seizure.
	Pump coupling or shaft sheared.	Check shaft engagement and damage. Replace the necessary parts.
	System relief valve stuck open.	Disassemble and clean the valve with solvent. Use pressure gauge to adjust the relief valve.
	Pump or motor binding.	Remove and disassemble the unit. Check for correct assembly of parts. Also check for dirt or metal chips. Clean the parts thoroughly and replace any damaged parts.
MOTOR NOT DEVELOPING SUFFICIENT SPEED OR TORQUE	Insufficient pump speed.	Check pump drive speed.
	Insufficient fluid pressure.	Check delivery of pump. Make certain sufficient hydraulic fluid is available to the pump.
	System overload relief valve set too low.	Check pressure and reset relief valve.
	Motor requiring excessive torque.	Remove motor and check torque requirements of driven shaft.
	Parts of motor cartridge scored due to excessive pressure or foreign matter in oil.	Remove motor for overhaul.
MOTOR TURNING IN WRONG DIRECTION	Improper port connections or control	Reverse port connections or shift valve.
	Components in system not functioning as intended.	Check complete system for proper operation.
MOTOR NOISY	Air in system.	Bleed air from highest point in system and replenish fluid.
	Motor internally damaged.	Remove motor for overhaul.
	Noise from other system components telegraphing back through lines and emerging from motor.	Check complete system for proper operation.
EXTERNAL LEAKAGE FROM MOTOR	Worn seals or cut "O" rings.	Install new seals and "O" rings.
MOTOR SHAFT CONTINUING TO ROTATE WHEN CONTROL IS IN "OFF" POSITION	Control valve is not functioning properly.	Check control valve for correct spool and leakage.

SECTION VI - OVERHAUL

A. GENERAL

Plug all removed units and cap all lines to prevent the entry of dirt into the system during shutdown. During disassembly, pay particular attention to identification of the parts for correct assembly.

Figure 9 is an exploded view which shows the proper relationship of the parts for disassembly and assembly. Figure 1 can be referred to for the correct assembled relationship.

NOTE

Preassembled replacement cartridges are available for rapid field overhaul of these motors. If a replacement cartridge is being used, proceed as in step B-1 following for disassembly and step D-7 and D-8 for reassembly.

B. DISASSEMBLY

1. Cover End - Clamp the motor in a vise with protective jaws, cover end up.

Remove the four cover bolts and lift off the cover. Remove the cartridge from the body. If the cartridge is not being replaced as an assembly, remove two screws and separate the pressure plates from the rotor, ring, vanes and springs.

NOTE

Use a standard piston ring compressor of suitable size when disassembling and assembling the cartridge components.

Carefully pull the rotor and vane assembly halfway out of ring and install the ring compressor (see figure 10). Compress the vanes into the rotor and remove this assembly from ring. Release the ring compressor and disassemble components. Remove the "O" ring and back-up rings from the pressure plate and body.

2. Shaft End - Remove the shaft key. Carefully pull the hub adapter from the body with the adapter puller tool (see figure 8). Remove spirolox ring next to the shaft bearing from the body, then tap the shaft and bearing assembly out. If it is necessary to remove the small snap ring and bearing from the shaft, support the bearing inner race in an arbor press, remove snap ring and press bearing off the shaft. Remove washer and then shaft seal and wiper from the body.

C. INSPECTION AND REPAIR

1. Discard the shaft seal, wiper, "O" rings and back-up rings. Use a new seal kit for reassembly. (See parts catalogs.) Wash the metal parts in clean petroleum solvent, blow them dry with filtered compressed air and place on a clean surface for inspection.

2. Check the wearing surfaces of the cartridge pressure plates and ring for scoring and wear. Replace any scored or worn parts.

3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Carefully remove burrs with a medium India stone (Norton abrasives MF724 knife type stone for flat surfaces and MF214 round type stones with 60° conical ends for inside corners). Replace the rotor if the slots are worn. Replace vanes with a new vane and spring kit if the vane tips are worn.

4. Rotate the bearing on the shaft while applying pressure to check for wear, looseness, roughness and pitted or cracked races.

5. Inspect the seal and bushing mating surfaces on the shaft for scoring or wear. Replace the shaft if marks cannot be removed by light polishing.

6. Be sure that any paint or burrs raised on the body and cover mating surfaces are removed before reassembly.

D. REASSEMBLY

NOTE

Coat all parts with clean hydraulic fluid to facilitate reassembly and provide initial lubrication. Use small amounts of petroleum jelly to hold the "O" rings in place during assembly. Soak the shaft wiper in oil before reassembly.

1. Shaft Seal Assembly - Install the shaft wiper in the body. Grease the shaft seal and press it into the body with the seal driver (figure 7). The spring on the shaft seal must be toward the bearing. Place the washer in the body against the shaft seal.

2. Shaft Assembly - Support the bearing inner race and press in the shaft. Install the tru-arc snap ring on the shaft. Lightly tap the shaft and bearing assembly into the body with a plastic hammer. Install the spirolox ring in the body to secure the bearing and shaft. Thoroughly inspect to insure that spirolox ring is correctly installed.

3. Cartridge Assembly - With the rotor lying on a clean, flat surface, slide the vanes and springs into the rotor slots. Lift the vanes slightly to insure the springs are positioned in the spring recesses of the rotor. With a piston ring compressor of suitable size, compress the vanes in the slots so the vanes will clear the minor diameter of the ring. (See figure 10.)

CAUTION

Be certain the springs remain seated in the spring recesses of the rotor as vanes are compressed.

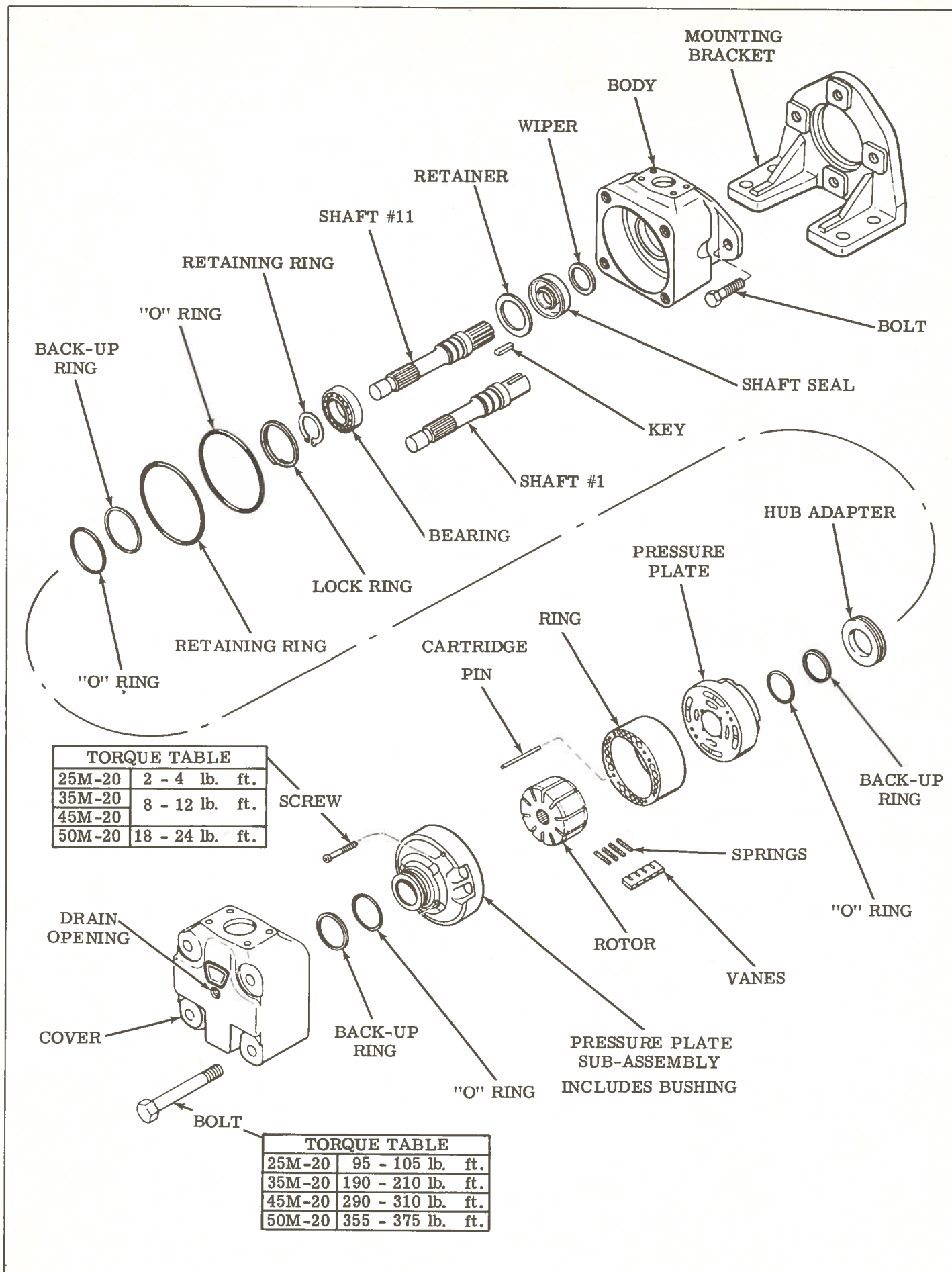


Figure 9

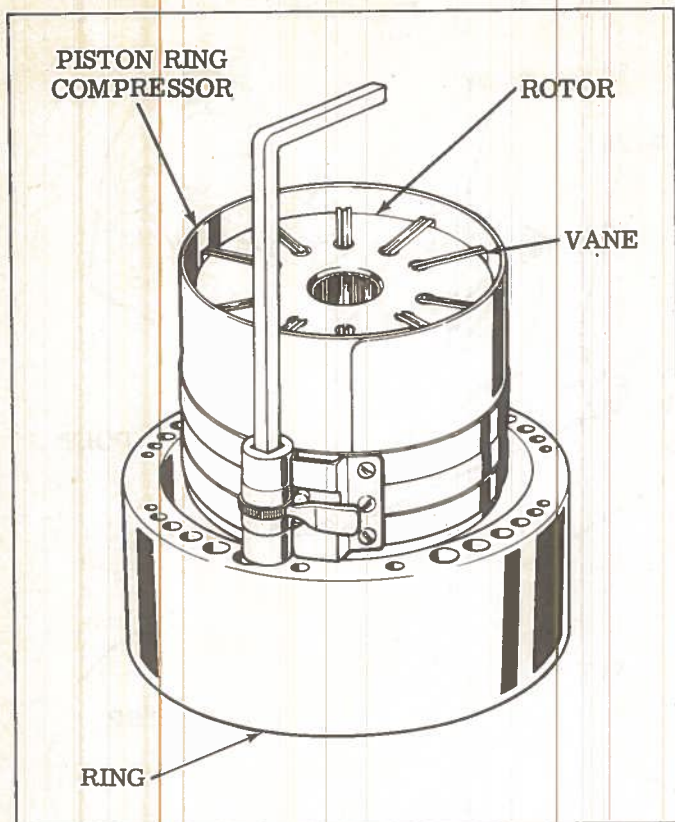


Figure 10

4. Vanes and Rotor - Position the ring on a flat surface and insert the rotor and vane assembly 1/4 way into the ring. Use a suitable size hard wood plug as a driver for positioning the rotor and vane assembly (see Table V). Release the compressor carefully so the vanes do not snap out against the ring surface. With the hard wood plug, press the vanes and rotor flush with the ring.

NOTE

Vanes may become cocked if not pushed down uniformly.

SECTION VII - TESTING OF VANE MOTORS

Vickers Mobile Division application engineering personnel should be consulted for test stand circuit requirements and construction. If test equipment is

TABLE V - ROTOR DRIVER DIMENSIONS

MOTOR SIZE	DIAMETER	APPROX LENGTH
25M-20	2.80	1.50
35M-20	3.36	2.00
45M-20	3.95	2.50
50M-20	4.50	2.75

5. Cartridge Pins - Install the cartridge pins on the body end pressure plate (plate without bushing). Place the rotor, ring and vane assembly over the pins on the plate.

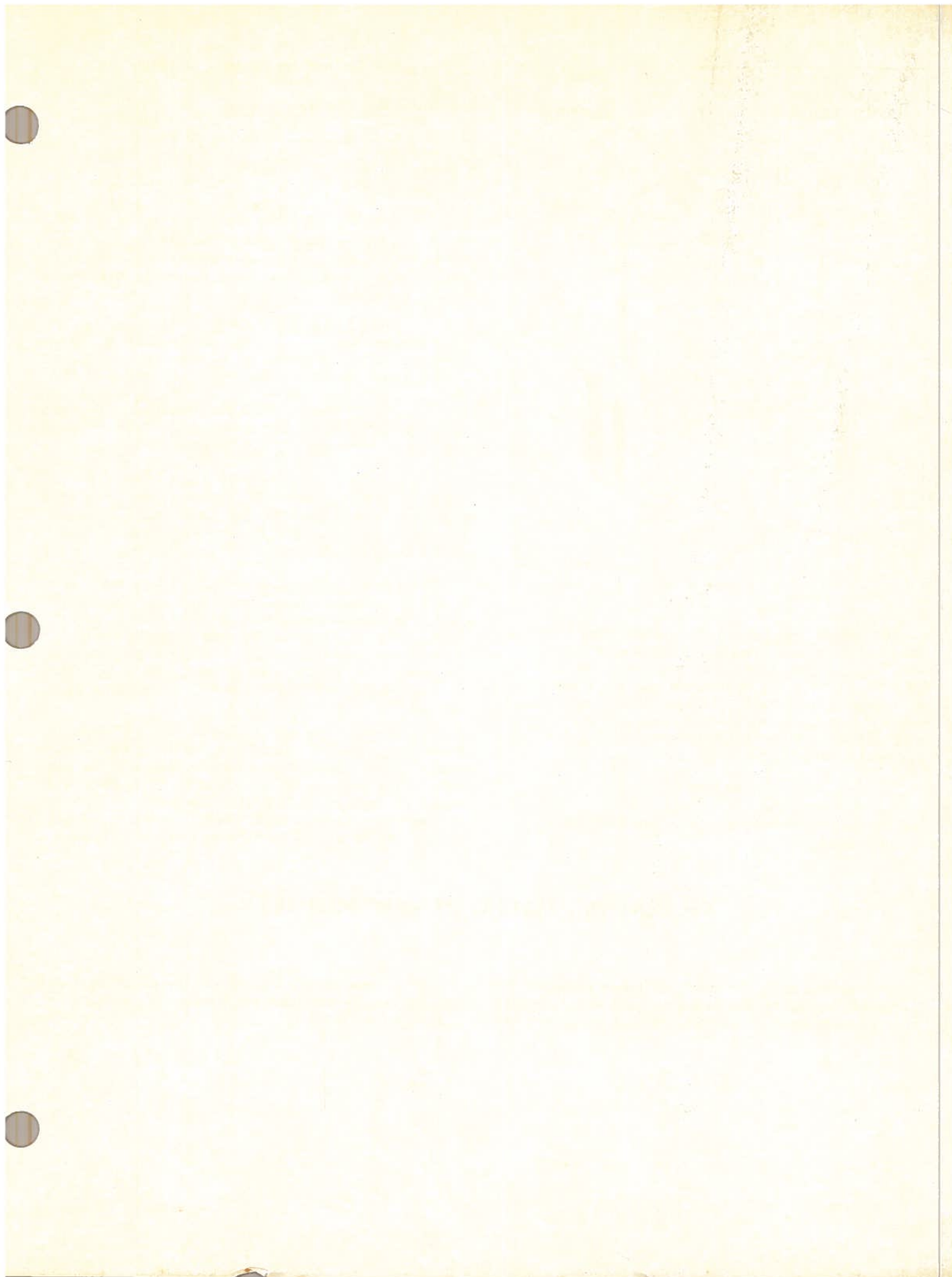
6. Cover End Pressure Plate - Install the cover end pressure plate against the rotor and ring. The porting in this plate will be 90 degrees from the other plate. Carefully install the two cap screws in the cartridge. Tighten the screws to values shown in fig. 9, page 11, being certain the peripheral edges of the ring and plates are flush. Tap with a plastic hammer if necessary to effect alignment.

7. "O" Rings and Back-up Rings - Install back-up rings first and then "O" rings on the pressure plate hubs. Grease with petroleum jelly. Inspect this assembly to insure that the "O" ring is positioned in the concave side of the back-up ring.

8. Cartridge Installation - Clamp the body in a vise with protective jaws. Assemble the hub adapter on the cartridge pressure plate (body end). Install back-up ring and then the "O" ring on the hub adapter. Grease with petroleum jelly. Install the cartridge on the shaft, with the hub adapter toward the body. Tap the cartridge into position. Install the retaining ring the body.

9. Cover Assembly - Install the "O" Ring in the cover, greasing liberally. Carefully install the cover, being sure the locating pin engages the pin hole in the cover. To check engagement, turn the cover 30 degrees in both directions and be certain the cartridge moves with it. Install four cover bolts and tighten to torque requirement shown in figure 9.

available, the motor should be tested at recommended speeds and pressures shown on installation drawings (see Table I).

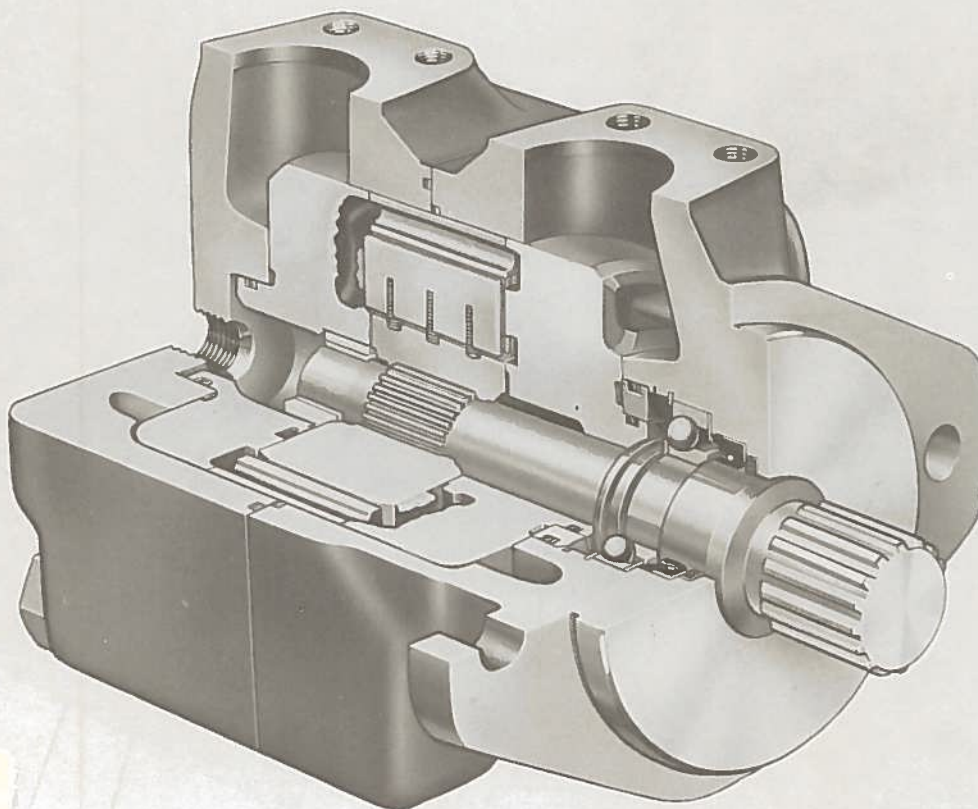


Service Parts Information

Vane
Motors

25M & 26M Series
-20 Design

10



1401 Crooks Road
Troy, Michigan

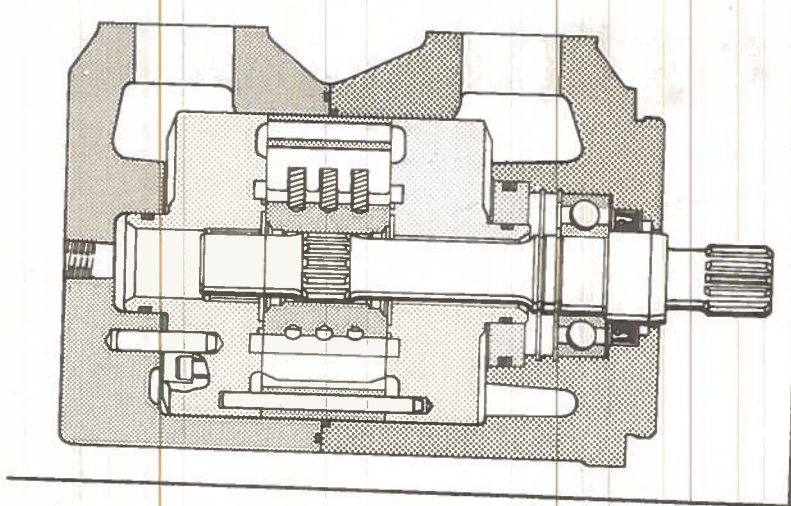
Revised 9-1-85

M-2741-S

MOI

RECOM-
KITTS ARE
SHIPMENT.

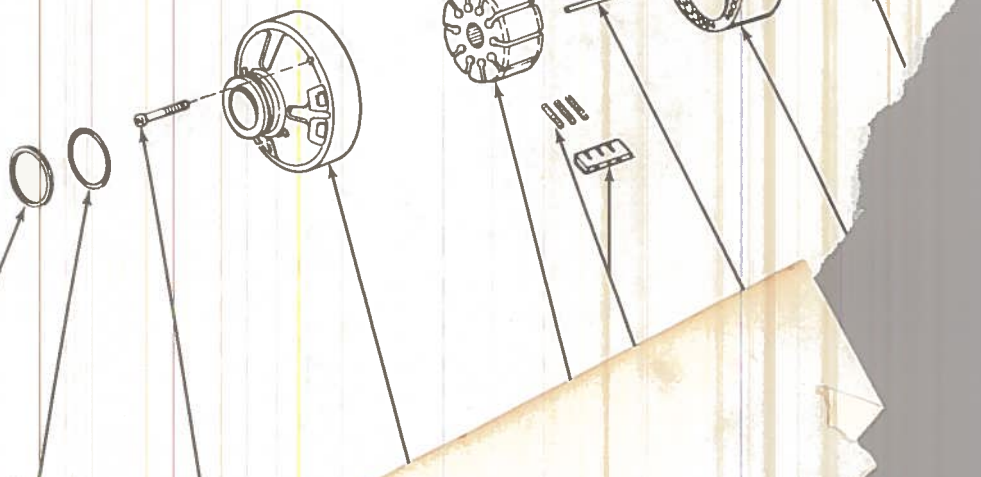
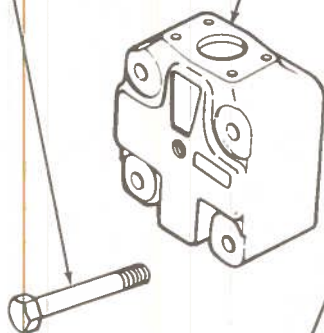
fluid which meets ISO
standards are recommended.
Litho in U.S.A.



312152 HUB

MODEL DESIGNATION	COVER
2*M * A - **20	312140
2*M * B - **20	317283

11165 SCREW (4 REQ'D)
TORQUE TO
100 ± 5 lb. ft.



MODEL DESIGNATION	CARTRIDGE KIT	BACK-UP RING	"O RING	SCREW (2 REQ'D) TORQUE 2-4
2*M 42*-**20	923160	▲271699		
2*M 55*-**20	923161			
2*M 65*-**20	923162			

MODEL CODE BREAKDOWN

20 - ** *
 * M * T T T *
 * M * T T T *
 * M * T T T *

SPECIAL FEATURES
 DESIGN NUMBER

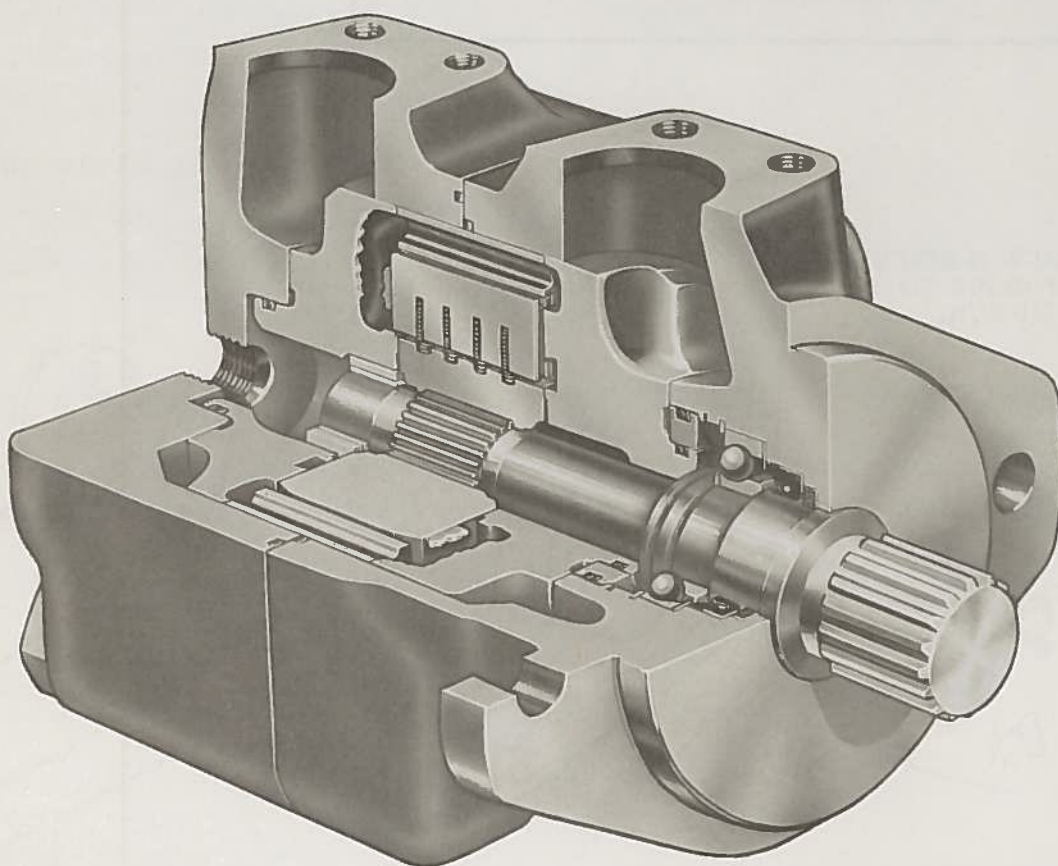
VICKERS

Service Parts Information

**Vane
Motors**

45M & 46M Series - 10 Design

11



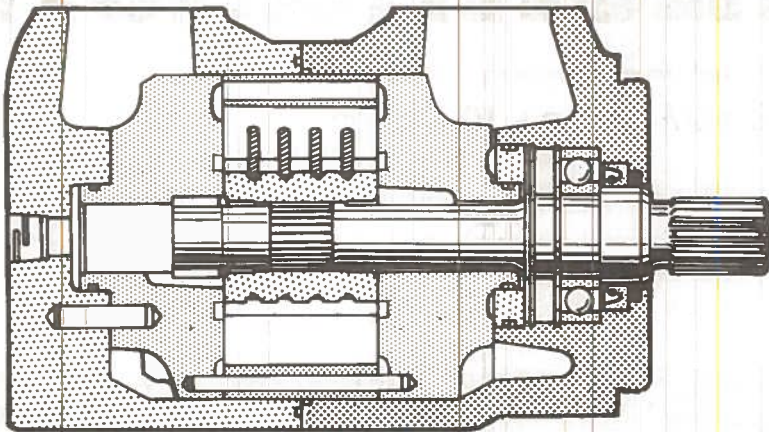
Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

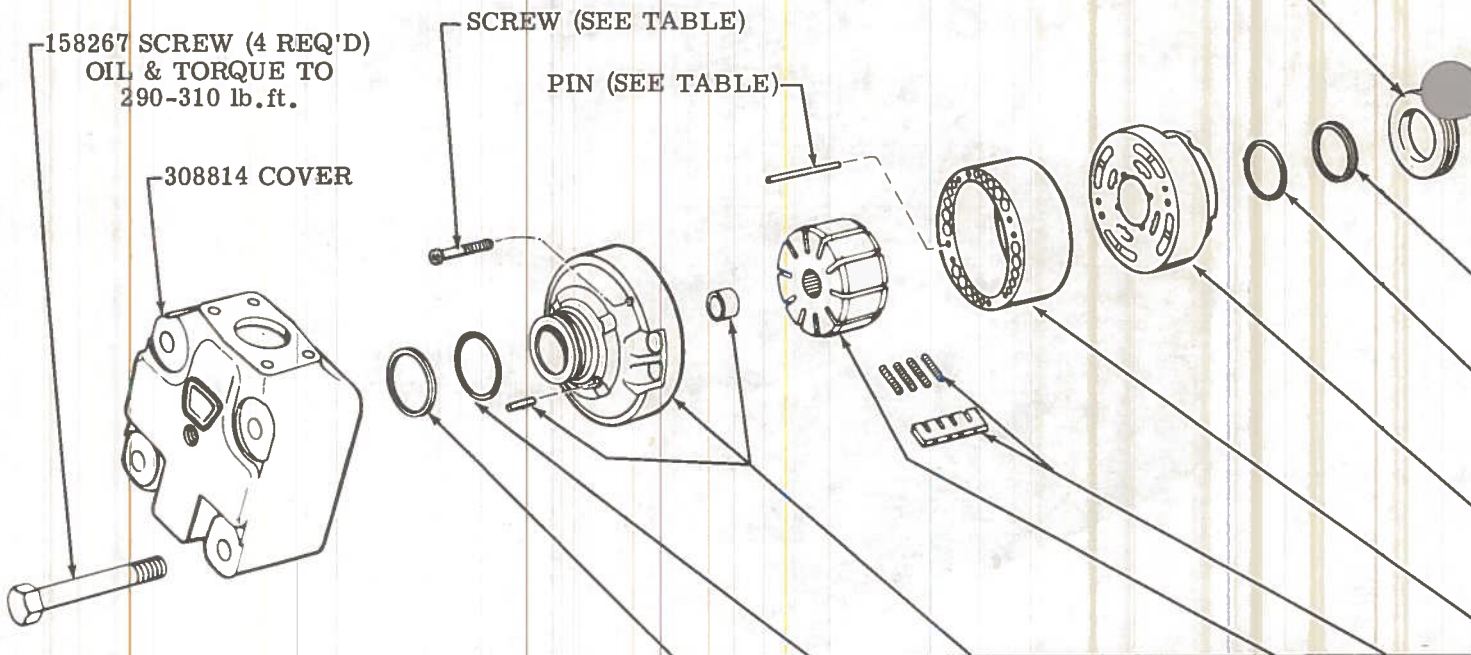
Revised 11-1-85

M-2743-S

A Libbey-Owens-Ford Company



311145 HUB ADAPTER



MODEL	CARTRIDGE KIT	SCREW (2 REQ'D) OIL & TORQUE TO 8-12 lb.ft.	BACK-UP RING	"O"RING	PRESS. PLATE S/A (INCLUDES BUSHING AND PINS)	PIN (2 REQ'D)	ROTOR	VANE KIT 10 VANES 40 SPRINGS
4*M130*-**20	923111	255837	▲271738	▲199816	309403	194898	307209	923108
4*M155*-**20	923110							
4*M185*-**20	923109							

THESE PARTS ARE INCLUDED

MODEL DESIGNATION	SHAFT	KEY
4*M ** - 1* 20	309404	217596
4*M ** - 11* 20	309405	—

193220 RETAINER

▲ 394974 SHAFT SEAL

▲ 197411 WIPER

102949 RETAINING RING

193144 LOCK RING

MODEL	BEARING
45M***-**20	8618
46M***-**20	309926

212464 SCREW
(2 REQ'D)

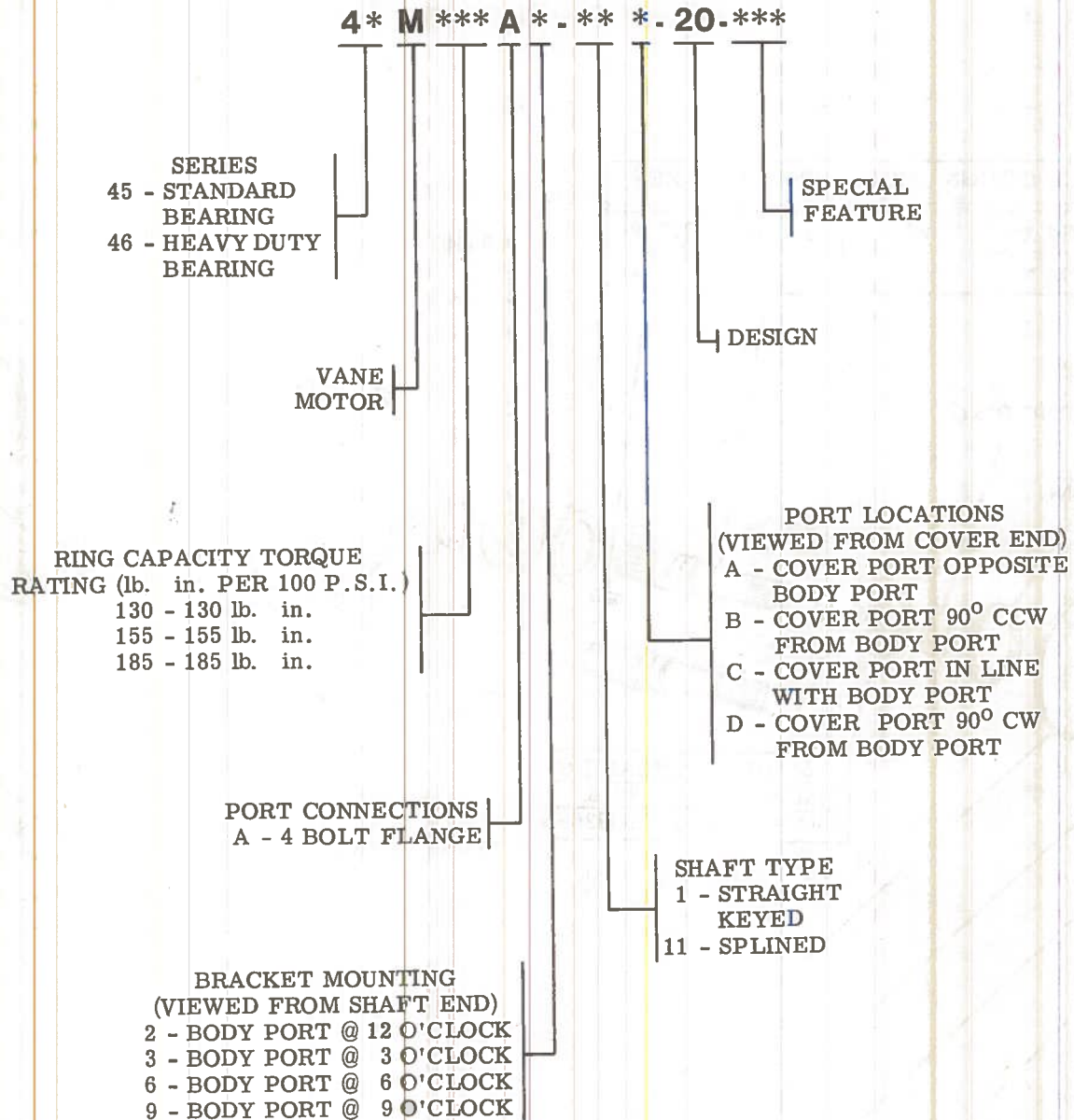
308813 BODY

FB-C-10
(INCLUDES SCREWS)

▲ INCLUDED IN
SEAL KIT 923106

PRESS. PLATE	"O"RING	BACK-UP RING	"O"RING	BACK-UP RING	"O"RING	"O"RING
CARTRIDGE KIT						
309402	▲199816	▲ 271738	▲ 154085	▲ 271795	▲309009	▲ 257447

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U.S.A.

Service Parts Information

12



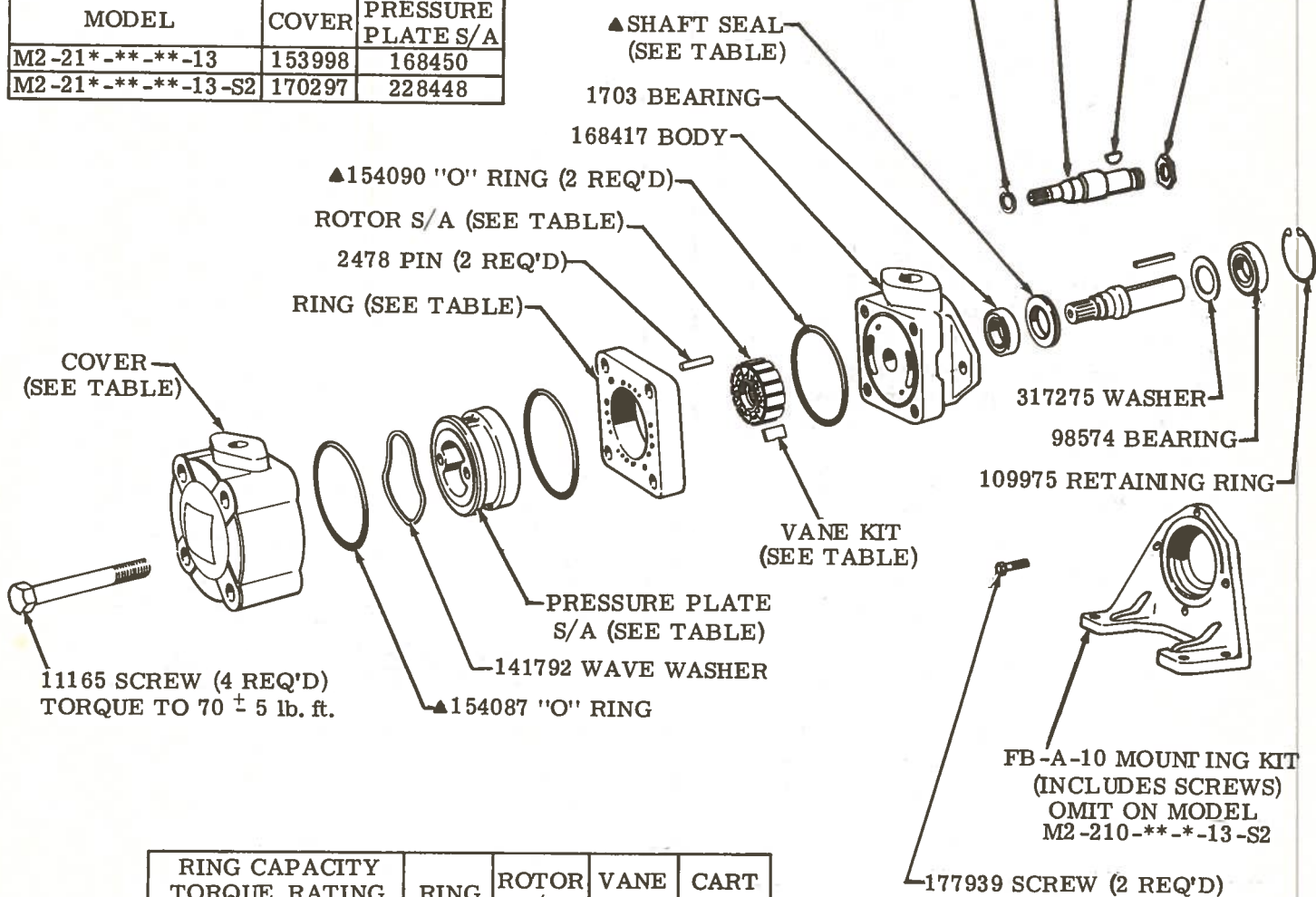
VANE MOTORS

M2-200 Series

▲INCLUDED
IN SEAL KIT

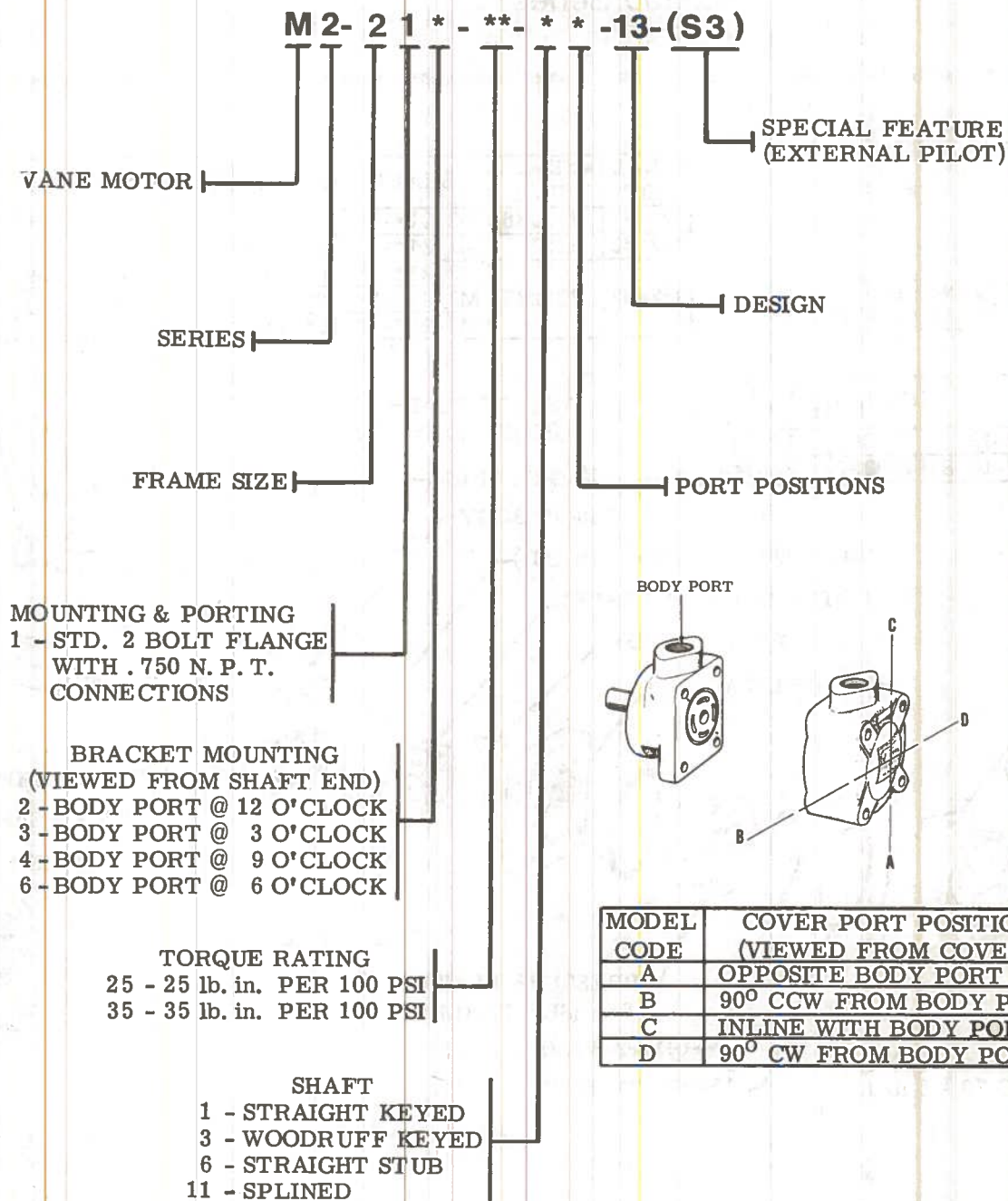
▲SEAL KIT	▲SHAFT SEAL	SHAFT TYPE	RET. RING	SHAFT	KEY	NUT
922832	229236	M2-21*-**-1*-13	—	116644	5881	—
922833	229235	M2-21*-**-3*-13	98653	120037	1615	132260
922832	229236	M2-21*-**-6*-13	—	131420	1609	—
		M2-21*-**-9*-13	—	128300	—	—
		M2-21*-**-11*-13	—	133178	—	—

MODEL	COVER	PRESSURE PLATE S/A
M2-21*-**-**-13	153998	168450
M2-21*-**-**-13-S2	170297	228448



RING CAPACITY TORQUE RATING (lb. in./100 PSI)	RING	ROTOR S/A	VANE KIT	CART KIT
M2-21*-25*-**-13	168419	168439	912073	922834
M2-21*-25*-**-13-S2		172294		941203
M2-21*-35*-**-13	168418	168440		922835
M2-21*-35*-**-13-S2		172294		941204

MODEL CODE BREAKDOWN



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

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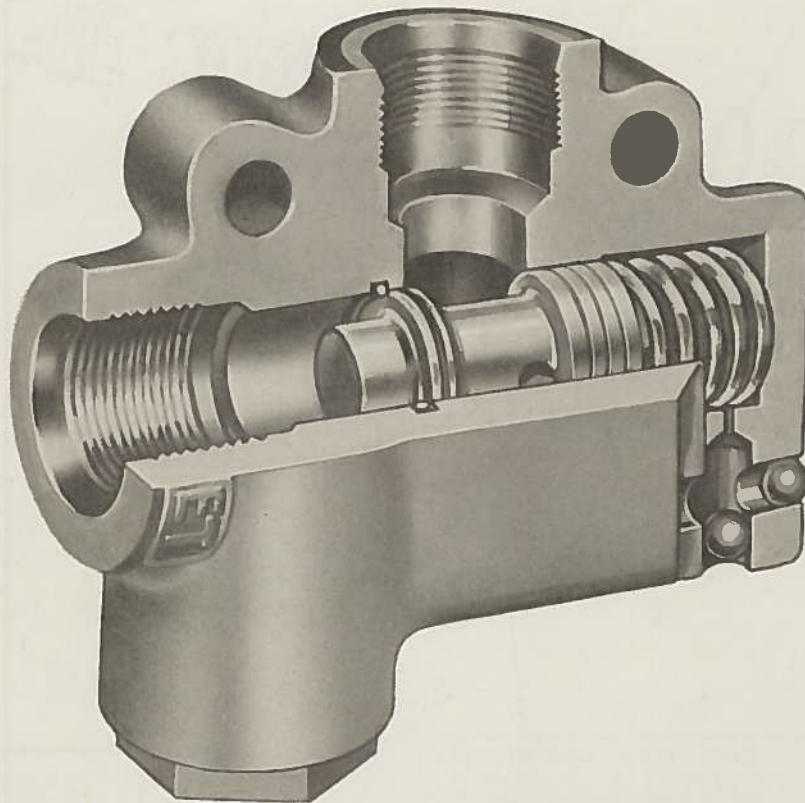
VICKERS

Service Parts Information

Flow
Control
& Relief
Valves

FM2, FM3 and RM3

13



Vickers, Incorporated

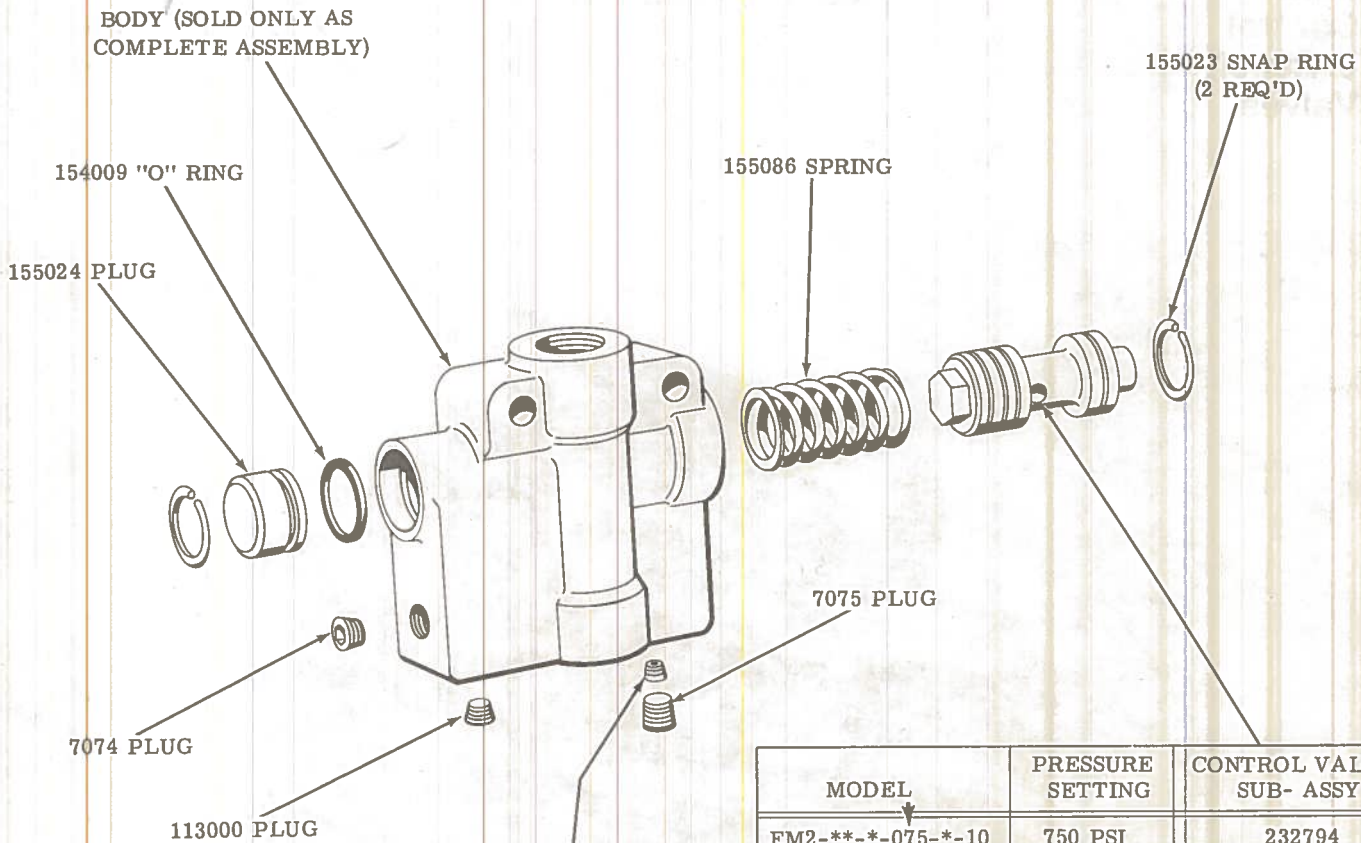
1401 Crooks Road
Troy, Michigan 48064

Revised 11-1-85

M-2551-S

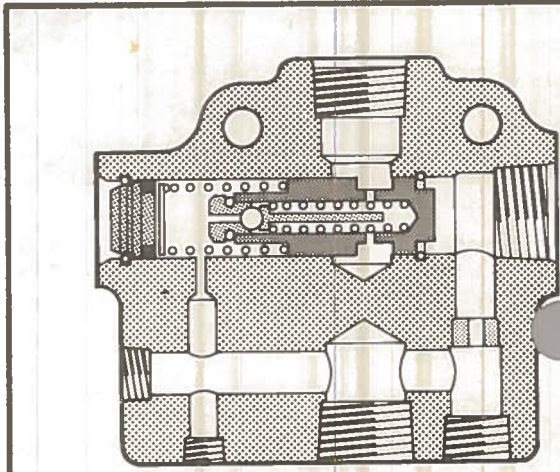
A Libbey-Owens-Ford Company

FM2-0* -1*-*-10-S*



MODEL	PRESSURE SETTING	CONTROL VALVE SUB- ASSY
FM2-**-*-075-*-10	750 PSI	232794
FM2-**-*-100-*-10	1000 PSI	232795
FM2-**-*-125-*-10	1250 PSI	232796
FM2-**-*-150-*-10	1500 PSI	232797
FM2-**-*-175-*-10	1750 PSI	232798
FM2-**-*-200-*-10	2000 PSI	232799

MODEL	CAPACITY (GPM)	RESTRICTION PLUG
FM2-**-*-2-10	2	167463
FM2-**-*-4-10	4	167464
FM2-**-*-6-10	6	167465
FM2-**-*-7-10	7	165359
FM2-**-*-8-10	8	167466

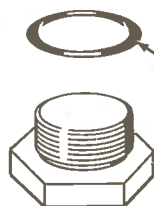
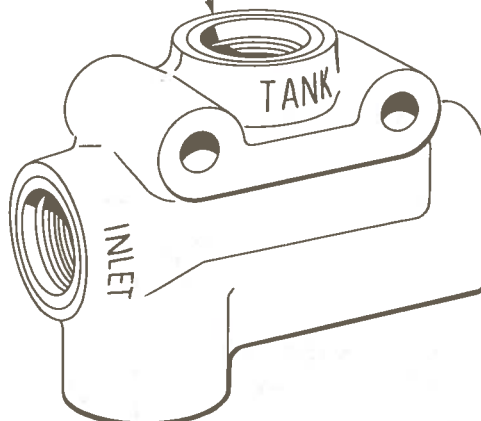


M3-**-**--10**

BODY NOT SOLD SEPARATELY.
ORDER BY COMPLETE
MODEL NUMBER

230661 SNAP RING

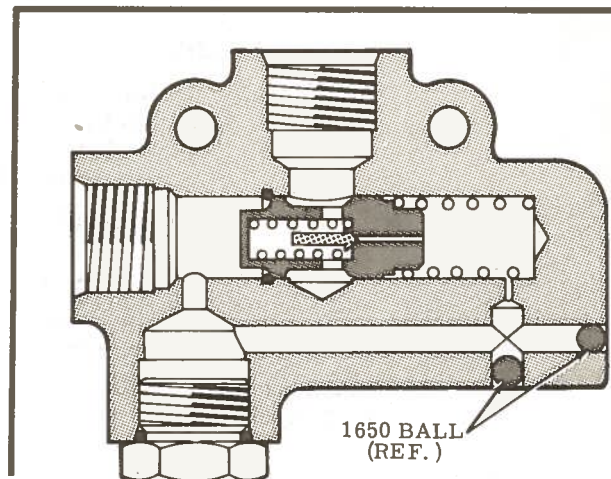
239766 SPRING



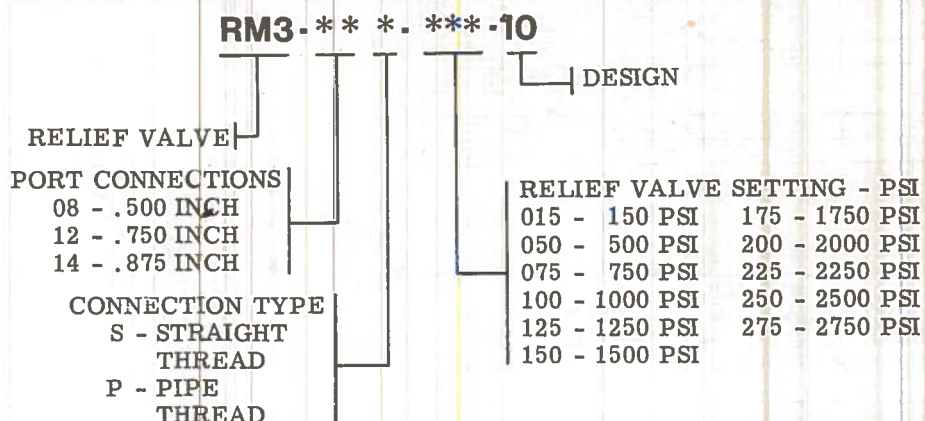
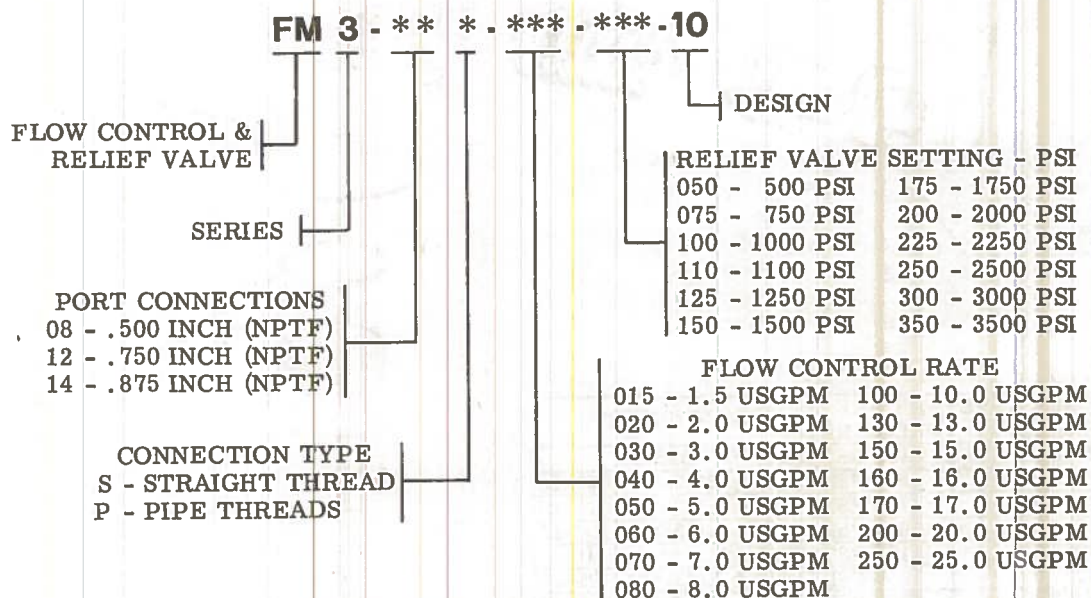
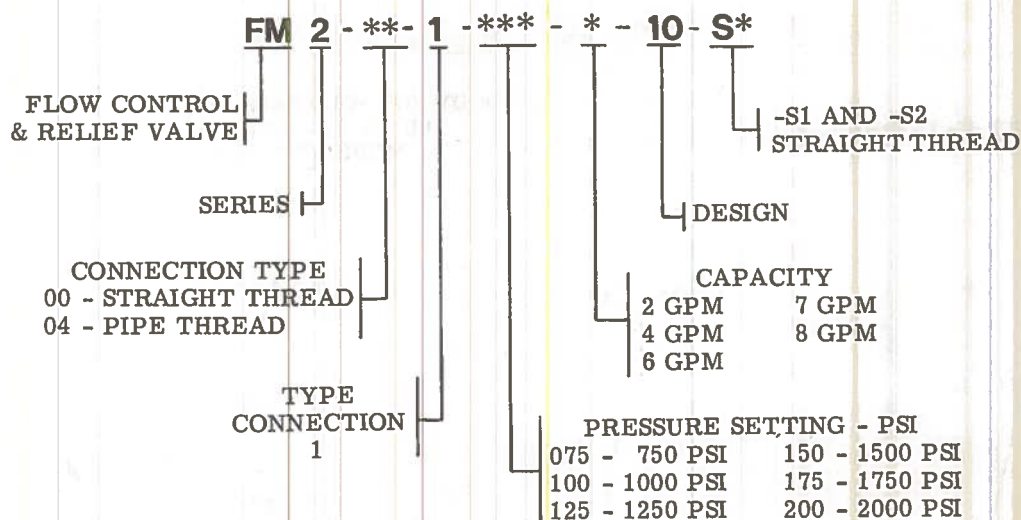
CONTROL VALVE SUB-ASSY	RELIEF PRESSURE	MODEL
284219	150 PSI	RM3-***-015-10
233018	500 PSI	FM3 & RM3-***-050-10
232794	750 PSI	FM3 & RM3-***-075-10
232795	1000 PSI	FM3 & RM3-***-100-10
265620	1100 PSI	FM3-***-***-110-10
232796	1250 PSI	FM3 & RM3-***-125-10
232797	1500 PSI	FM3 & RM3-***-150-10
232798	1750 PSI	FM3 & RM3-***-175-10
232799	2000 PSI	FM3 & RM3-***-200-10
233019	2250 PSI	FM3 & RM3-***-225-10
233020	2500 PSI	FM3 & RM3-***-250-10
266200	2750 PSI	RM3-***-275-10
■ 266054	3000 PSI	FM3-***-***-300-10
■ 277557	3500 PSI	FM3-***-***-350-10

MODEL	PLUG	"O" RING
RM3-12S-***-10	186580	154129
RM3-14S-***-10	181792	154130
RM3-08P-***-10	7077	—

■ CAUTION
MODELS WITH CRACKING PRESSURES 3000 PSI
AND ABOVE REQUIRE -005 MODEL SUFFIX
FEATURE. (NPT 7074 PLUG IN PLACE OF 1650
BALL)



MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFF, OFR, and OFRS series are recommended.

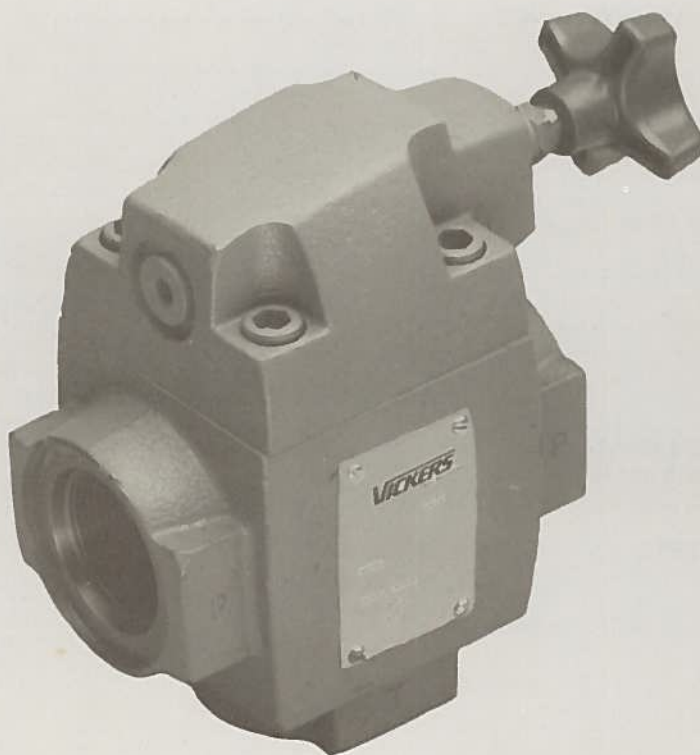
Litho in U.S.A.

Overhaul Manual

**Balanced Piston
Relief Valves**

**CG/CS/CS5-03/06/10 Series
CT/CT5/CG5-06/10 Series**

14



SECTION

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Section I - INTRODUCTION

A. PURPOSE OF MANUAL

This manual describes operational characteristics, maintenance requirements, and overhaul information for Vickers balance piston relief valves. Information contained herein pertains to the latest design models that are listed in Table 1.

MODEL
CT/CS-10-**-30
CT/CS/CG-H10-**-30
CT/CS/CG-06-**-50
CT/CS/CG-H06-**-50
CS-03-**-50
CS5-03-***-**-90
CT5/CG5-06/*10-***-**-90

Table 1

B. RELATED PUBLICATIONS

Service parts and installation dimensions are not contained in this manual. The parts and installation drawings listed in Table 2 are available from any Vickers sales engineering office or from:

Vickers, Incorporated
Technical Publications
1401 Crooks Road
Troy, Michigan 48084

MODEL DESCRIPTION	PARTS & SERVICE DRAWING	INSTALLATION DRAWING
CG-06-**-20	I-3302-S	510900
CG-06-**-40	I-3306-S	510900
CG-06-**-50	I-3368-S	510900
CG-H06-*V-50	I-3366-S	510900
CG-H10-*V-30	I-3399-S	510900
CG-10-**-20	I-3301-S	510900
CG-10-**-30	I-3697-S	510900
CS-03-**-20	I-3301-S	510500
CS-03-**-40	I-3305-S	510500
CS-03-**-50	I-3369-S	510500
CS-06-**-20	I-3304-S	510500
CS-H06-*V-50	I-3367-S	510500
CS-H10-*V-30	I-3699-S	510500
CS-10-**-20	I-3304-S	510500
CS-10-**-30	I-3698-S	510500
CT-06-**-20	I-3301-S	510500
CT-06-**-40	I-3305-S	510500
CT-06-**-50	I-3369-S	510500
CT-H06-*V-50	I-3367-S	510500
CT-H10-*V-30	I-3699-S	510500
CT-10-**-20	I-3301-S	510500
CT-10-**-30	I-3698-S	510500
CS5-*03-***-**-70 **-**-70	I-3364-S	511005
CS5-*03-***-**-80 *-**-80	I-3679-S	511005
CS5-*03-***-**-81 *-**-81	I-3691-S	511005
CS5-*03-***-**-90 *-**-90		511006
CG5/CS5/CT5-06-***-**-70	I-3364-S	511005
CG5/CS5/CT5-06-***-**-80	I-3679-S	511005
CG5/CS5/CT5-06-***-**-81	I-3691-S	511005
CG5/CS5/CT5-10-***-**-70	I-3365-S	511005
CG5/CS5/CT5-10-***-**-80/81	I-3680-S	511005
CG5/CS5/CT5-10-***-**-90		511006

Table 2. Related Publications

C. MODEL CODES

Variations within each model series are covered in the model code. See Table 3. Each unit has a model code stamped into the

nameplate. Service inquiries should always include the complete model number as noted on the nameplate.

MODEL CODE BREAKDOWN

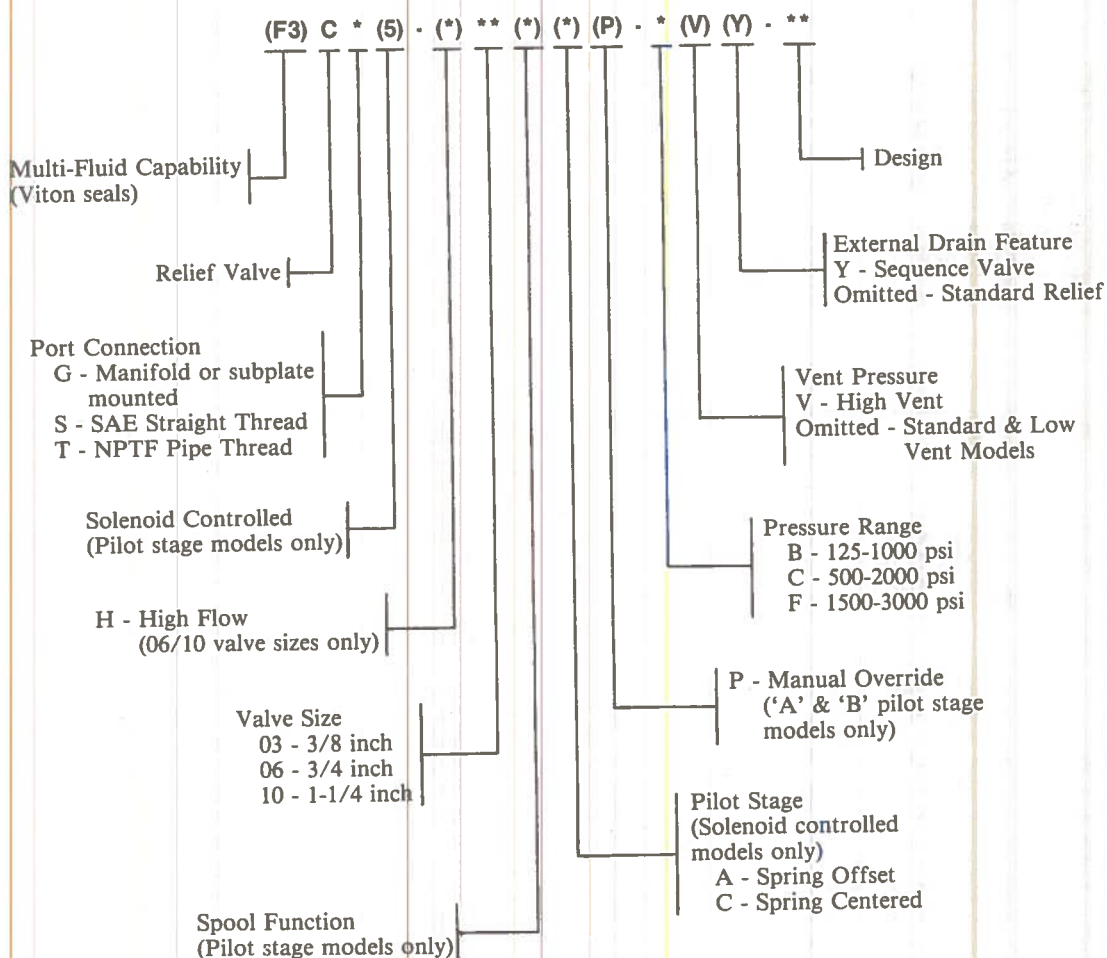


Table 3. Model Code

Section II - DESCRIPTION

A. GENERAL

Relief valves are devices used to limit maximum pressure in hydraulic systems. When system pressure starts to exceed the pressure setting of the relief valve, a controlled amount of hydraulic fluid bypasses through the tank port and limits the system pressure to the valve setting. A fine incremented adjustment assures precise regulation over wide pressure ranges.

A Vickers relief valve provides a fast response with very low pressure override characteristics because of its two-stage

balance piston design. The balance piston relief valve is so named because in normal operation it is in hydraulic balance. Further details are discussed in Section III.

B. BASIC PARTS

Relief valves consist of two sections: the cover section and the body section. The cover section includes a pressure adjustment screw, a heavy spring, a poppet, a seat, and a vent connection. The body section includes a piston, a light spring, a seat, and the port connections.

Section III - PRINCIPLES OF OPERATION

A. PRESSURE RELIEF

Figure 1 illustrates the basic valve operation. The valve pressure setting is determined by the adjusting screw position which varies the heavy spring compression. The balanced piston is normally held against the seat by the light spring. System pressure is present in chamber A and is connected to chamber B through orifice C.

The closed position of the valve is shown in Figure 1A. With system pressure less than the valve setting, the pilot poppet is held against its seat by spring force. Pressures in chambers A and B equalize through orifice C. Thus, the piston is hydraulically in balance and held against its seat by the light spring.

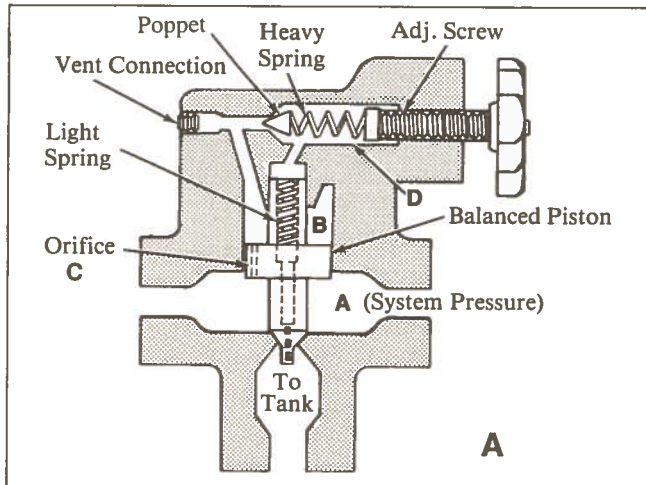


Figure 1A.

In Figure 1B the valve is shown throttling fluid to the tank port. This occurs when system pressure exceeds the heavy spring setting and forces the poppet away from its seat.

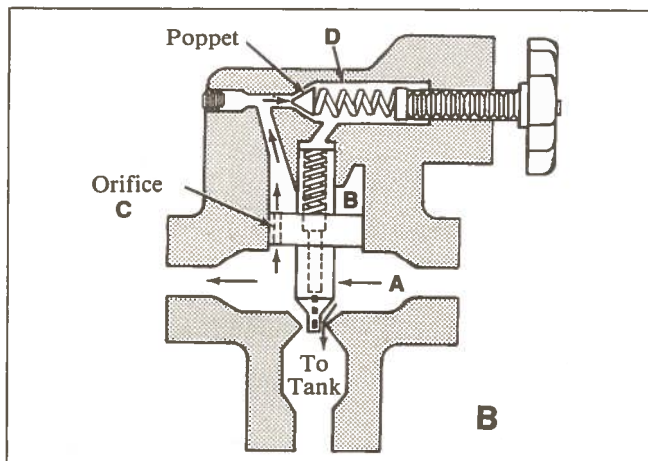


Figure 1B.

Fluid then flows through orifice C and chamber B, past the poppet into chamber D, and down through the drain hole in the center of the piston to the tank port.

The pressure in chamber B is limited by the setting of the heavy spring. When pressure in chamber A exceeds chamber B sufficiently, pressure unbalance overcomes the force of the light spring and lifts the piston. Excess fluid then flows past the bottom of the piston to tank.

When system pressure drops below the valve setting, the poppet reseats. Control flow through orifice C stops and pressures in chambers A and B are again effectively equalized.

The light spring then forces the piston toward the seat while orifice C continues to equalize pressure between chambers A and B. When the balance piston is closed against its seat, all flow through orifice C stops.

B. VENTING

The "High-Vent" option ("V" in the model code) is used when it is necessary to maintain pilot pressure for other valves in the system. This option provides a faster valve de-venting (closing) action. Higher pressure (approximately 80 PSIG) is maintained when the valve is vented because a heavier piston spring is used.

Relief valves can be vented to unload pump delivery to tank in the following manner:

Connect a shut-off valve to the vent port of the main relief valve. Chamber 'B' above the balanced piston can be opened to tank (see Figure 1B). This removes pressure at the top of the balanced piston. Pressure in chamber 'A' overcomes the light spring, unseats the balanced piston, and diverts all pump delivery to tank.

A solenoid controlled directional valve (C*5) may be used to vent flow to tank. This directional valve is mounted on top of a standard relief valve to form a single package. See Figure 6.

C. REMOTE CONTROL

The main relief valve may be adjusted from a remote location by using another adjustable valve similar in function to the main relief valve pilot stage (see Figure 2). Flow past the poppet of the remote control valve is directed to tank. The following rules should be maintained for optimum results:

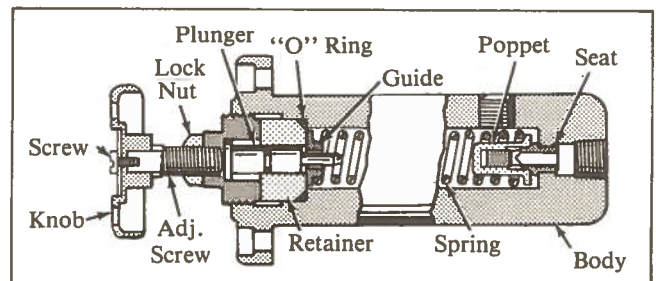


Figure 2.

1. Keep hydraulic lines (tubing) as short as possible.
2. Set main relief valve 200-300 PSIG above maximum operating pressure. DO NOT exceed the valve pressure rating.
3. Set remote control valve to maximum operating pressure.
4. Check system for stability characteristics. If the system is unstable, reduce the line length and/or proceed to step 5.
5. Install an orifice in the vent opening of the main relief valve cover and in the pressure port of the remote control valve. DO NOT go below 0.040 inch diameter or a malfunction could result. Orifices should be as large as possible to prevent excessive pressure drop and still maintain noise free operation.

Section IV - INSTALLATION

A. INSTALLATION DRAWINGS

The installation drawings listed in Table 2 show installation dimensions, port locations and operating parameters. Manifold, subplate and bolt kit information is also included.

NOTE

The tank line must be piped directly to tank to minimize back pressure. The drain line from the remotely operated valve (vent valve) must also be directly piped to tank. Any pressure in the drain line is additive to the pressure setting of the valve.

B. CIRCUIT CONNECTION.

Threaded type CT/CS valves are usually connected directly in the pressure line. Circuit flow passes through the ports located on opposite sides of the valve body. The bottom port (opposite the cover) is the return flow port and is connected to tank. These valves may be teed into the pressure line by plugging or blocking one of the pressure outlet ports.

CG type gasket mounted valves are teed into pressure lines. The tee is connected to the pressure port of the valve sub-plate or manifold. The return port is connected to tank. The valve must be mounted against a flat, ported, mounting surface.

Repair or replacement of CG valves is simplified in that piping need not be disturbed.

C. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended cleaning methods are sandblasting, wire brushing and pickling. Refer to instruction sheet 1221-S for pickling instructions.

2. To minimize flow resistance and the possibility of external leakage, use only the necessary fittings and connections required for proper installation.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of fluid flow. Tubing must not be bent too sharply. The recommended radius for tube bends is three times the inside diameter.

D. FLUIDS AND SEALS

Standard seals (Nitrile) can be used with petroleum, water glycols, and water-oil emulsion type fluids.

F3 seals (Viton*) can be used with all commonly used industrial hydraulic fluids. Viton* is compatible with petroleum, water-base and synthetic fire-resistant fluids.

*Trademark of Dupont De Nemours Co., Inc.

Section V - INSPECTION & MAINTENANCE

A. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the system can result. Loose connections also permit air to be drawn into the system resulting in noisy and/or erratic operation.

2. Air bubbles in the reservoir can ruin the valve and other components. If bubbles are seen, locate the source of air and seal the leak.

B. CLEANLINESS

Clean fluid is the best insurance for long service life. Therefore, check the reservoir periodically for dirt and other contaminants. If the fluid becomes contaminated, flush the entire system and add new fluid.

To insure your hydraulic system is clean, perform the following steps:

1. Clean (flush) the entire system to remove paint, metal chips, welding shot, etc.

2. Filter each oil change to prevent introduction of contaminants.

3. Provide continuous oil filtration to remove sludge,

products of wear and corrosion generated during the life of the system.

4. Provide protection to all areas that can introduce airborne contaminants into the system.

5. Perform regular servicing procedures of filters, breathers, and reservoirs.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, pour it through a fine wire screen (200 mesh or finer). DO NOT use a cloth to strain the fluid because lint may enter the system. When applicable, pump the fluid through a 10 micron filter or use a PFTU (porta filter and transfer unit). For PFTU information, order bulletin 366.

D. HYDRAULIC FLUID RECOMMENDATIONS

Hydraulic fluid within the system performs the dual function of lubrication and transmission of power. To insure proper lubrication, system life, and component reliability, fluid selection should be made carefully with the assistance of a reputable supplier. Fluid selection should be acceptable for use with all valves, motors and pumps within the system. Data sheets for fluid selection are available from Vickers, Inc., 1401 Crooks Road, Troy MI 48084, Attn. Technical Publications. For Industrial applications, order data sheet I-286-S.

The fluid recommendations noted in the data sheet are based on our experience in industry as a hydraulic component supplier. Where special considerations indicate a need to depart from these recommendations, see your Vickers sales representative.

E. OVERLOAD PROTECTION

A relief valve must be installed in the system as close to the pump as possible. The relief valve limits pressure in the system to a prescribed maximum. The setting of the relief valve depends on the work requirements of the system.

F. PRODUCT LIFE

The longevity of these products is dependent upon environ-

ment, duty cycle, operating parameters and system cleanliness. Since these parameters vary from application to application, the ultimate user must determine and establish the periodic maintenance required to maximize life and detect potential component failure.

G. TROUBLESHOOTING CHART

Table 4 lists the common difficulties experienced with pumps and hydraulic systems. It indicates probable causes and remedies for each of the troubles listed.

TROUBLE	PROBABLE CAUSE	REMEDY
ERRATIC PRESSURE	Foreign matter in system Worn poppet or seat in cover Piston sticking in body or cover	Drain, flush and refill system with clean fluid. Replace poppet and seat. Clean piston. Remove burrs by light lapping. Check freedom of movement on reassembly. Replace if necessary.
LOW PRESSURE OR NO PRESSURE	Valve improperly adjusted Vent connection open Balance hole in piston plugged Poppet in cover not seating	Adjust valve to proper setting. Plug vent connection. Remove piston and clean out. If necessary, drain system and refill with clean fluid. Back off adjusting screw several turns while running pump to be certain foreign matter is not caught on the seat. Check condition of seat, spring, and poppet if malfunction persists.
EXCESSIVE NOISE OR CHATTER	High oil velocity through valve Distorted control spring Worn poppet or seat in cover Excessive tank line pressure Vent line too long Valve setting too close to that of system operating pressure	Check valve flow rating. Replace with larger valve if necessary. Replace spring. Replace poppet and seat. Connect return port directly to tank. Place a restriction, eg. needle valve or orifice plug in vent line next to relief valve. Set relief valve at least 150 PSI higher than other valves in circuit.

Table 4. Troubleshooting Chart

Section VI - OVERHAUL

A. UNIT REMOVAL

WARNING

Turn off all electrical power and relieve any hydraulic pressure. Block any load that could generate pressure.

1. Remove relief valve from system.
2. Drain appropriate hydraulic lines and remove the valve from system.
3. Cap all system openings to prevent contamination.
4. Place the relief valve on a clean work bench.

B. SERVICE TOOLS

The following tools are recommended to overhaul a CG, CS, CT, or C*5 relief valve.

STANDARD TOOLS AND EQUIPMENT:

1. A 6 inch crescent wrench.
2. One set of hex key wrenches with a socket adaptor.
3. Petroleum jelly or grease that is compatible with hydraulic fluids.
4. Cleaning solvent.
5. A small ball peen hammer.
6. One medium size screwdriver.
7. One torque wrench (0-250 lb.in.)
8. A clean work bench that is equipped with a vise.
9. Shop air (90 psi).

SPECIAL TOOLS

Depending on the extent of repair, the following special tools are recommended.

1. A piece of drill rod or roll steel to remove the seat within the valve body. See Figure 3.

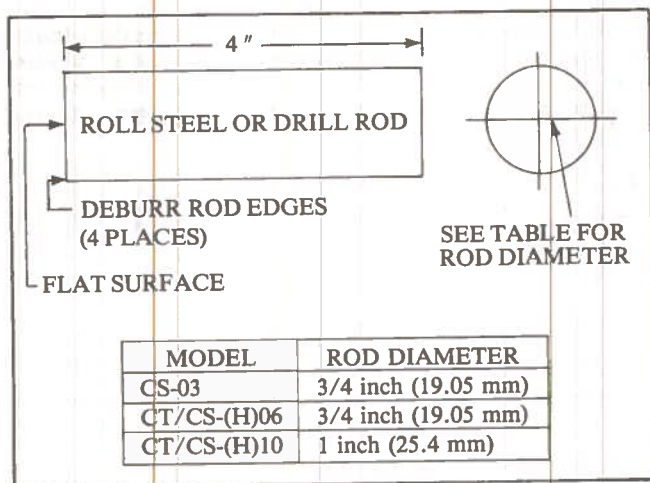


Figure 3. Disassembly Tool to Remove Seat (19) from Body (21)

2. One screw (approximately 4 inches long), two washers, and one nut. This particular tool is needed to remove the seat and/or sleeve from the body of CG (subplate mounted) models only. See Figure 4.

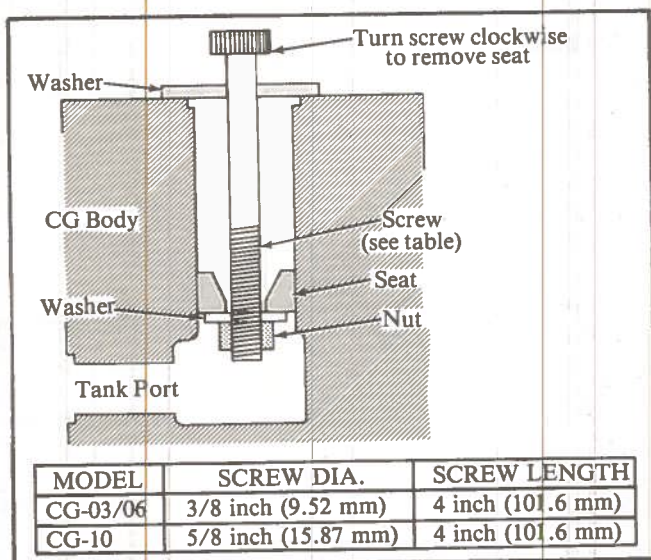


Figure 4. Seat (19) Removal Tool (CG Models)

C. DISASSEMBLY

Periodic maintenance of the relief valve will generally not require disassembly to the extent described here. However, the following disassembly sequence can be used as a guide for partial disassembly. In general, disassembly is accomplished by item number sequence shown in Figure 5.

1. Thoroughly clean the valve exterior with cleaning solvent.
2. Secure valve body (21) in a vise.
3. Loosen lock nut (2).
4. Turn knob (1) counterclockwise and remove knob from valve cover (14). (Note: An adjusting screw replaces the knob on C*5 models.)
5. Remove parts (3) through (8). Inspect poppet (8) for damage to sealing surface. If poppet (8) is damaged, replace

with a new cover subassembly.

6. Inspect seat (12) for nicks, scratches, and washout. If the seat shows evidence of damage, replace with a new cover subassembly. DO NOT attempt to remove seat (12) from cover (14).

7. If seat (12) is in good condition, remove plug (9), seal (10), and spacer (11). (NOTE: Spacer (11) exists on C*-10-*** models only.)

8. Remove four screws (13) from cover (14), then disassemble the cover from body (21).

9. Remove parts (15) through (18) from body (21). Inspect piston (18) sealing surface for heavy scratches and other damage. Discard seal (15).

10. If piston (18) is damaged, turn valve body (21) in vise so tank port faces up. Insert a rod (reference Figure 3) into the tank port against seat (19). Tap on rod end with hammer and remove the seat (19) from body (21). For C*-H**30/50 models, insert rod against sleeve (20) and remove sleeve and seat at the same time.

NOTE

The following step refers to CG models only.

11. If piston (18) is damaged, secure body (21) in vise so mounting surface is face up. Insert a screw through seat (19). See Section VI, B and Figure 4 for removal of seat (19).

12. Remove plug (22) from body (21). Remove seal (23) from plug (22).

13. Discard seals (6), (10), (15) and (23).

D. DISASSEMBLY (C*5 MODELS)

Except for removal of the solenoid operated directional valve, the disassembly sequence of a C*5 valve is essentially the same as a standard relief valve.

1. Remove the four nameplate screws (a) and loosen nameplate (b) from directional valve cover (c).
2. Loosen four screws (d) and remove directional valve (e) from valve cover (f).
3. Discard seals (g).
4. Disassemble the relief valve per Section VI, C and follow Figure 5.

NOTE

This manual does not cover the repair and/or overhaul of solenoid operated directional valves. If the directional valve causes the relief valve to become inoperative, obtain the necessary parts and service information for directional valves.

E. INSPECTION, REPAIR AND REPLACEMENT

NOTE

All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement very important.

NOTE

Reliable operation throughout the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and materials are used in the manufacture of our parts. Substitutions may result in early failure.

NOTE

Replace all parts that do not meet the following specifications.

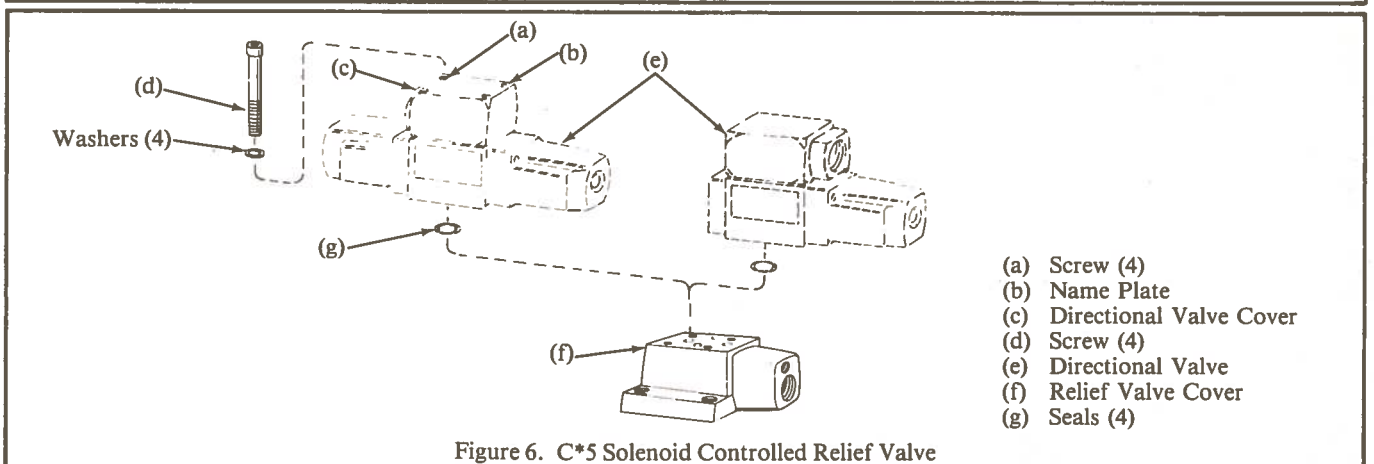
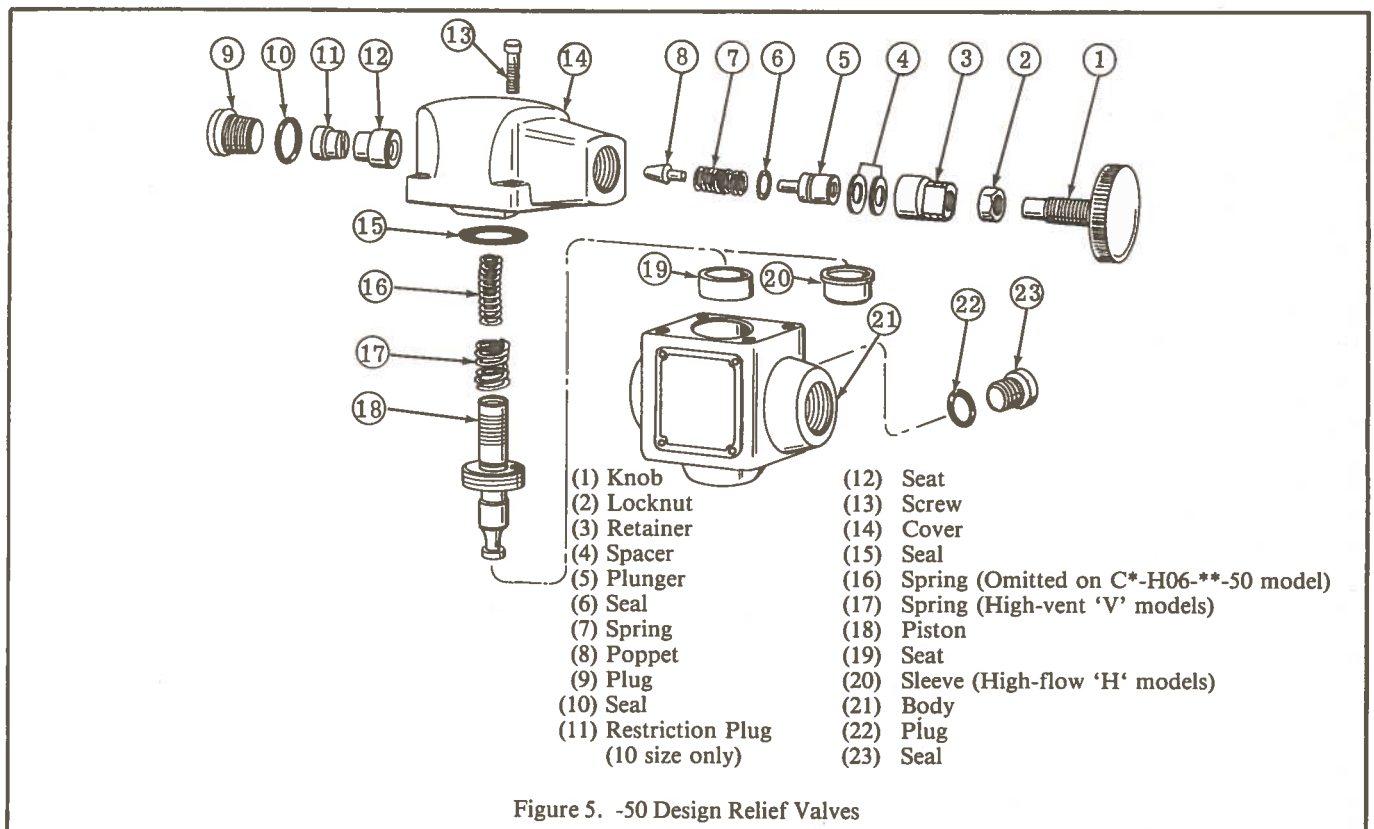
1. Inspect all screws (13) for evidence of damaged threads. If threads are damaged, replace the screws.
2. Inspect springs (7), (16), and (17) for distortion or damaged coils. Replace springs if coils are damaged.

3. Inspect the piston (18) to cover (14) clearance. Insert the piston into the cover and check for looseness. A close tolerance fit is mandatory for proper valve operation. If a loose fit is noted, the cover is worn and must be replaced.

4. Inspect the piston (18) to body (21) clearance. The piston should have a close tolerance fit as noted in step 3. If the piston is loose inside the body bore, replace the body and seat (19).

5. Inspect piston (18) for nicks or scratches across the sealing surface. Make sure the balance hole in the piston is free from foreign material. Remove minor scratches on piston with 500 grit polishing paper. If the piston has heavy scratches, replace the piston (18), seat (19), and body (21).

6. Inspect poppet (8) and seat (12) for heavy wear or evidence of washout. Replace both the poppet and seat if heavy wear or washout is noted.



7. If seat (19) was removed during disassembly, make sure inside of body (21) is clean and free from damage.

8. Inspect mounting surfaces on cover and body for burrs, nicks, or scratches. Remove burrs and/or scratches with India stone or polishing paper. Also check body and cover for damaged or worn threads. If threads are worn or damaged, replace the part.

F. ASSEMBLY

Assembly of parts will be in reverse numerical sequence as shown in Figure 5. Obtain new seals. Seal kits are noted on the parts and service drawings that are tabulated in Section I, B. Make sure all parts are clean prior to assembly. Lubricate all parts with a light film of clean hydraulic fluid.

1. Secure body (21) in a vise.

2. If sleeve (20) was removed during disassembly, insert the sleeve into bottom of body bore. NOTE: This step applies to C*-H**-30/50 models only.

3. If seat (19) was removed, install new seat into body (21) as follows:

a. Lubricate seat with petroleum jelly or grease that is compatible with system fluid.

b. Position the seat square over the body bore. Place a rod against the seat. Hold the rod centered. Tap on end of rod with hammer until seat is started into body, then drive the seat into the body bore until it bottoms out. Inspect the body and seat to be sure no chips or metal shavings were developed.

4. Install parts (18) through (15). NOTE: Spring (16) is used on high vent models only ('V' in the model code).

5. Slide piston (18) back and forth within the body bore. Also rotate the piston 360° to make sure piston movement is free and without bind.

6. Assemble cover (14) to body (21). Cross tighten four screws (13) evenly. Torque the screws to 14.9-20.3 Nm. (133-178 lb.in.).

7. Secure valve body in vise to a horizontal position. Place screwdriver or similar tool in tank port against bottom of piston (18). Push the piston up and down within the body. If the piston hangs up or binds, loosen screws (13) on cover (14) to a snug condition. Lightly tap around cover perimeter with a soft tip hammer until the piston moves freely within the body bore. Retighten the cover screws.

8. Install parts (11) through (9). NOTE: Restriction plug (11) exists in C*-10-** models only. Torque plug (9) to 22.6-27.1 Nm. (200-240 lb.in.).

9. Install parts (8) through (3). Be sure to install the same quantity of spacers (4) that were removed. The spacers determine the pressure adjustment range of the valve. Make sure seal (6) is assembled on plunger (5).

10. Install parts (2) and (1). Thread knob (1) in retainer (3) approximately five complete turns.

NOTE

The following step applies to C*5 solenoid operated relief valves only.

11. Assemble directional valve on cover in reverse alphabetical sequence as shown in Figure 6. Torque screws (d) to 5.6 Nm. maximum (50 lb.in.).

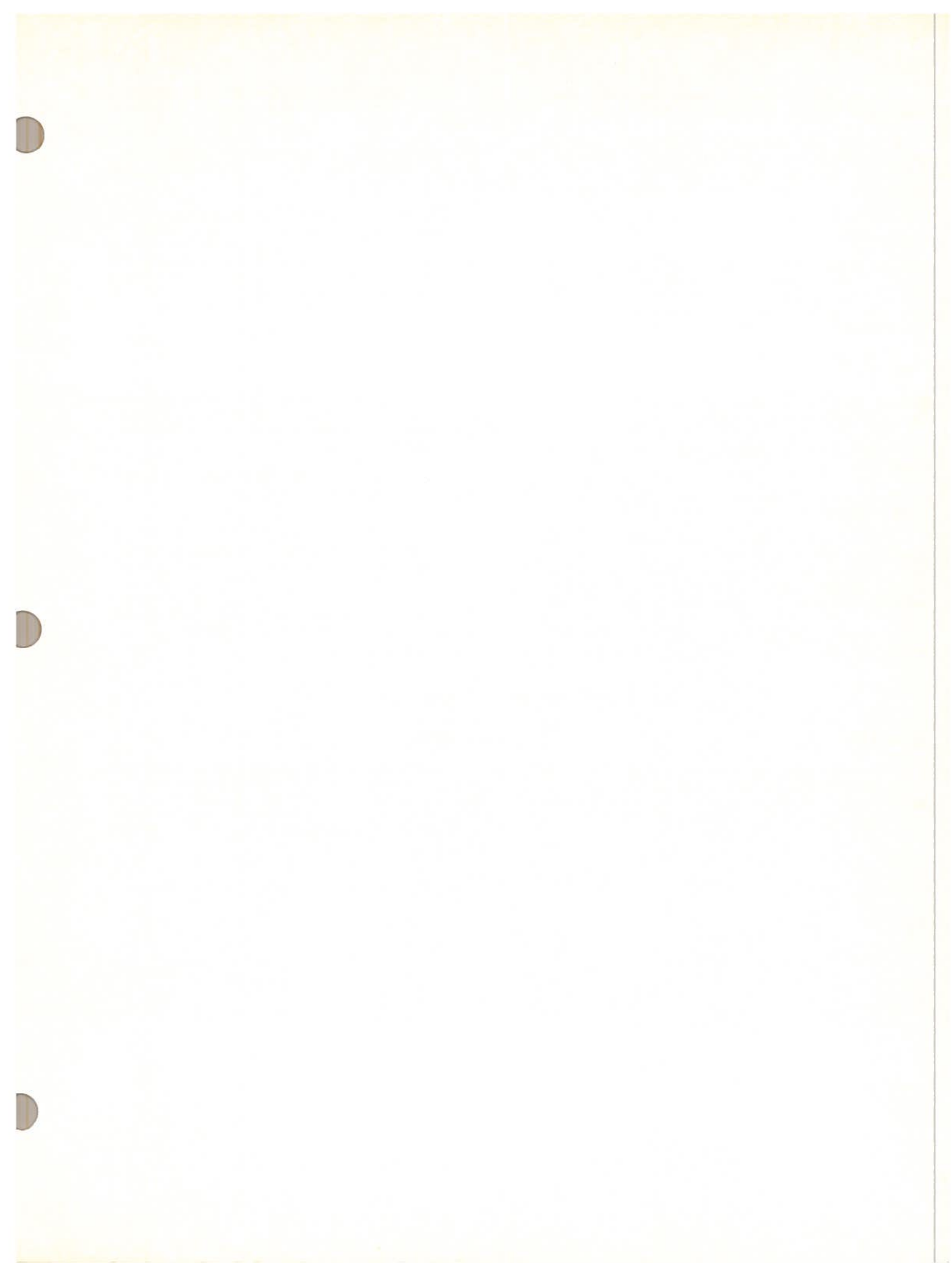
Section VII - START-UP AND TEST

A. START-UP

Start the system and sequence the unit through all positions while watching for appropriate movement of actuators. Improper or erratic movement of the actuators may indicate incorrect assembly of the unit or presence of trapped air.

B. TEST

A test stand having regulated flow, temperature control and special fixtures is required to fully test the performance of the rebuilt unit. Because of this, only the functional test shown in the start-up paragraph is given. If such a test stand is available, test the unit to the requirements set forth in the installation drawings.



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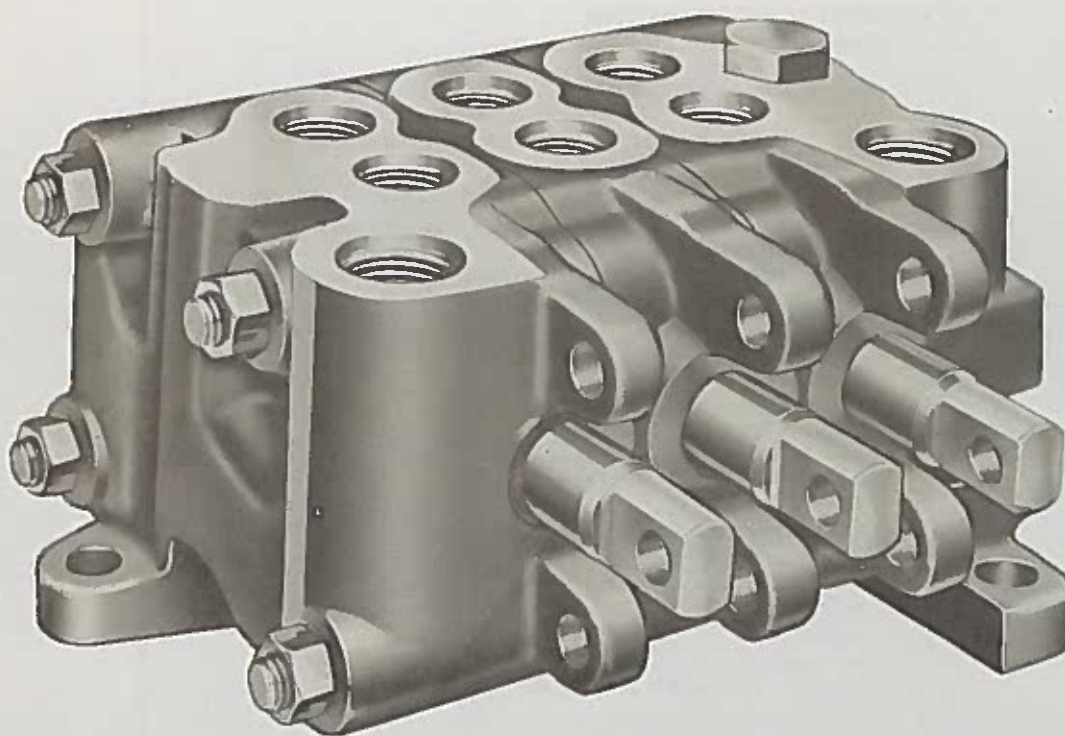
VICKERS

Overhaul Manual

**Multiple
Unit
Valves**

CM11 Series -21 Design

15



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 11-1-85

M-1780-S

A Libbey-Owens-Ford Company

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SECTION I - INTRODUCTION

A. PURPOSE OF MANUAL

Service information in this manual covers the principles of operation, installation, maintenance and repair of Vickers CM11 Series, -21 design Multiple Unit Valves.

B. GENERAL INFORMATION

Service parts information for these valves is contained in Parts Catalog M-1729-S. Oil recommendation information is shown on data sheet M-2950-S.

dimensions are on installation drawing 303. Copies are available on request from your local Vickers application engineering office or from: Vickers, Incorporated 1401 Crooks Road, Troy, Michigan 48408

Table I is a complete breakdown of the model code covering these units. Service inquiries should always include the complete model numbers which are stamped on the valve bodies.

TABLE I - MODEL CODE BREAKDOWN

CM 11 ZS 1 -R 25 V** ** * L - 21 ***									
MULTIPLE UNIT CONTROL VALVE			SERIES			SPECIAL FEATURE			
VALVE BANK MODIFICATION			DESIGN			OUTLET BODY TYPE			
NO - NO MODIFICATION						L - STANDARD			
ND - STANDARD SECTIONS - DUST COVERS						E - CARRYOVER PORT			
NS - STANDARD SECTIONS - ELECTRIC SWITCH ACTUATORS						E1 - E SECTION WITH ADDITIONAL OUTLET PORT			
ZO - NARROW BYPASS SECTIONS NO MODIFICATIONS									
ZD - NARROW BYPASS SECTIONS DUST COVERS									
ZS - NARROW BYPASS SECTIONS ELECTRIC SWITCH ACTUATORS									
PORT CONNECTIONS						SPOOL MODIFICATION (OMIT IF NOT REQUIRED)			
1 - 7/8-14 UNF - 2B INLET AND DISCHARGE PORTS - 3/4-16 UNF - 2B CYLINDER PORTS						1 - DETENT FOR ANY SPOOL			
2 - 1 1/16-12 UNF - 2B INLET & DISCHARGE PORTS - 7/8-14 UNF - 2B CYLINDER PORTS						2 - LIGHT CENTERING SPRING			
						7 - HALF LOAD CENTERING SPRING			
INLET BODY TYPE						SPOOL TYPE			
F - CARRYOVER PORT - NO RELIEF VALVE						A6 - COUNTERBALANCE			
R - STANDARD - RELIEF VALVE (PARTIAL FLOW BYPASS)						B - MOTOR			
K - STANDARD - RELIEF VALVE (FULL FLOW BYPASS)						C - FLOAT			
J - STANDARD - RELIEF VALVE (PARTIAL FLOW BYPASS)						D - DOUBLE ACTING			
						D3 - DUAL FUNCTION			
						D4 - SPECIAL METERING			
						D5 - COMBINED & B SPOOL FUNCTIONS			
						T - SINGLE ACTING			
						W3 - SAFETY INTERLOCK			
						ADJUSTABLE SYSTEM			
						RELIEF VALVE SETTING - PSI			
						(OMIT IF NOT REQUIRED)			
						V05 - 500 PSI V12 - 1250 PSI V20 - 2000 PSI			
						V07 - 750 PSI V15 - 1500 PSI V22 - 2250 PSI			
						V10 - 1000 PSI V17 - 1750 PSI V25 - 2500 PSI			
SYSTEM RELIEF VALVE SETTING - PSI									
05 - 500 PSI 12 - 1250 PSI 20 - 2000 PSI									
07 - 750 PSI 15 - 1500 PSI 22 - 2250 PSI									
10 - 1000 PSI 17 - 1750 PSI 25 - 2500 PSI									

SECTION II - DESCRIPTION

A. GENERAL

The CM11 - 21 Series Valves are made up of directional control valve sections mounted in banks and connected internally to common pressure and tank return passages. A valve bank usually consists of an inlet and operating (R*, K* or F*), a number of operating sections (*) and an operating and outlet section (*L or *E). Each operating section contains a sliding spool (for example A, B, C, T, D or W spool). In valve banks where only one operating section is required, an R* section is used with an L or E tank plate section.

B. ASSEMBLY AND CONSTRUCTION

Figure 1 is a cross-sectional view showing the construction and assembly of a three-section valve. Each section contains a sliding spool with centering springs and a check valve. The inlet section also contains a relief valve assembly.

Passages between the bodies connect each section to the common inlet and tank ports. Seal rings

between the sections seal the connecting passages. Sections are held together by studs and nuts.

C. OPTIONAL FEATURES

1. Micro-switch attachment - CM11*S models are equipped with a switch mounting bracket and a cam extension on the spool to actuate a micro-switch when the spool is shifted (see Section IV, paragraph F).

2. Spool detents - A spool detent assembly consists of a special end cap with a spring loaded plunger and a spool extension. The plunger engages in grooves in the spool extension to hold the spool in the desired position.

D. MOUNTING

CM11 Series -21 design valves are mounted with lugs cast into the inlet and outlet sections.

E. APPLICATION

Vickers application engineering personnel should be consulted for valve ratings and applications.

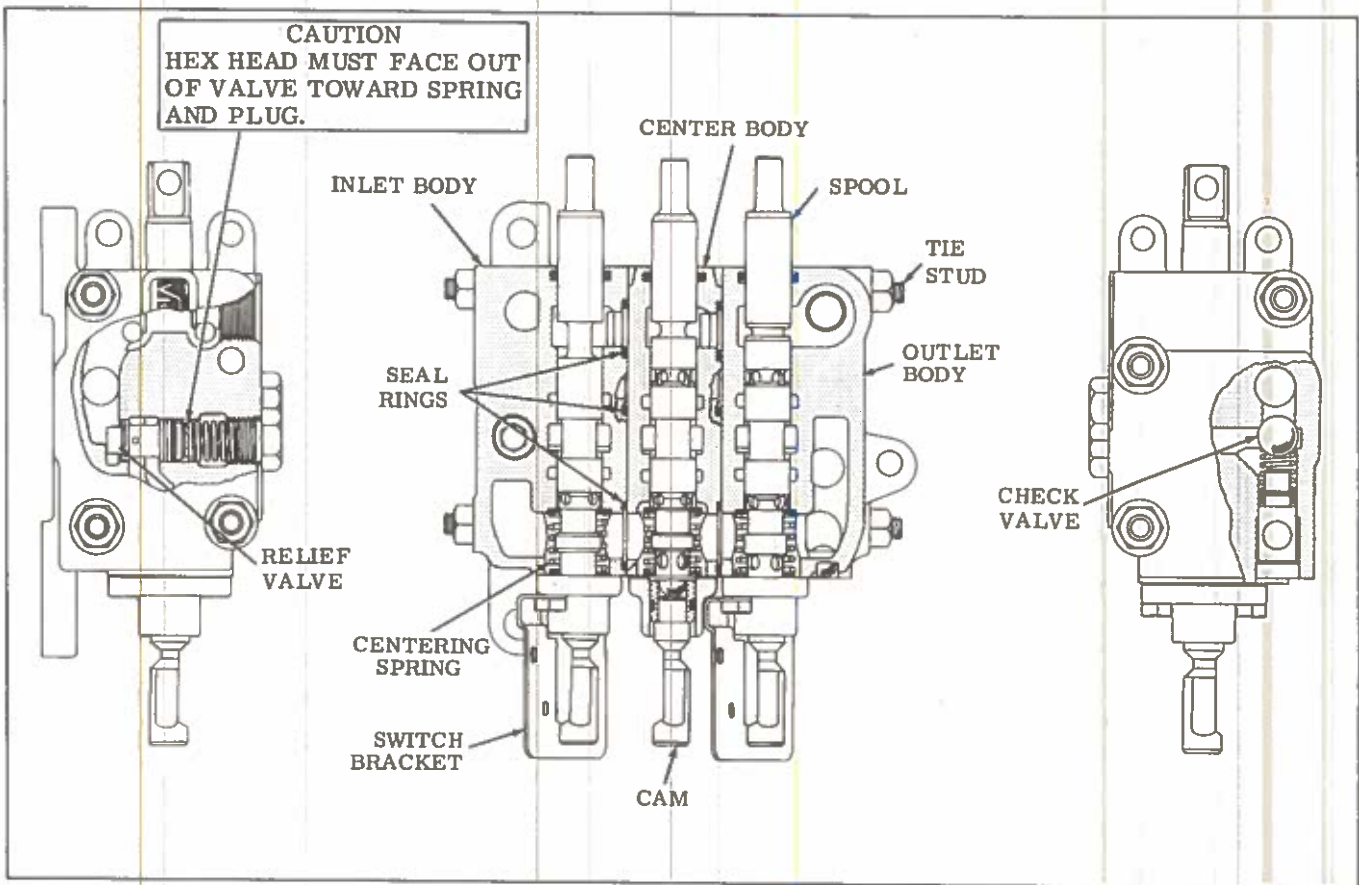


Figure 1

SECTION III - PRINCIPLES OF OPERATION

A. GENERAL

Figure 2 is a schematic illustration of a three section valve, showing the inlet and outlet ports and the by-pass, pressure and tank passages. The pressure passage is used to carry fluid to the cylinder ports when the spools are shifted. The by-pass passage permits flow directly to the outlet when the spools are not being operated. The tank passage also carries fluid to the outlet; either return flow from the cylinder ports or fluid diverted past the flow control and relief valve.

The spools are shown in the centered or neutral position. Under these conditions, fluid in the pressure passage is blocked from the cylinder ports by the spool lands. Flow through the valve is through the by-pass and tank passages to the outlet.

B. OPERATING SECTIONS

1. Inlet Sections - The CM11-21 Series valve bank may be obtained with operating, R*, F*, or K*, inlet sections. These sections are available with the spools listed in Table I.

These sections are individually described below.

(a) R* Section - The R* section is equipped with an integral relief valve for overload protection. It is built to accept a check valve to prevent return flow through the valve.

The integral relief valve, with an orifice plug, also acts as a partial flow control valve. This feature lowers the pressure drop between the inlet and outlet ports. (See paragraph 4 for relief valve and flow control operation.)

The relief valve cracking pressure is pre-set at the factory. The pre-set cracking pressures range up to 2500 psi maximum. (See Table I Model Code for pressure settings.)

(b) F* Section - The F* section has two pressure connections. One connection is made to the pump source and the second connection is made with a preceding valve assembly to accept the by-pass flow for tandem operation.

The F* section like the R* section is built to accept a check valve to prevent return flow when this feature is required. However, F* sections do not employ relief valve or partial flow by-pass.

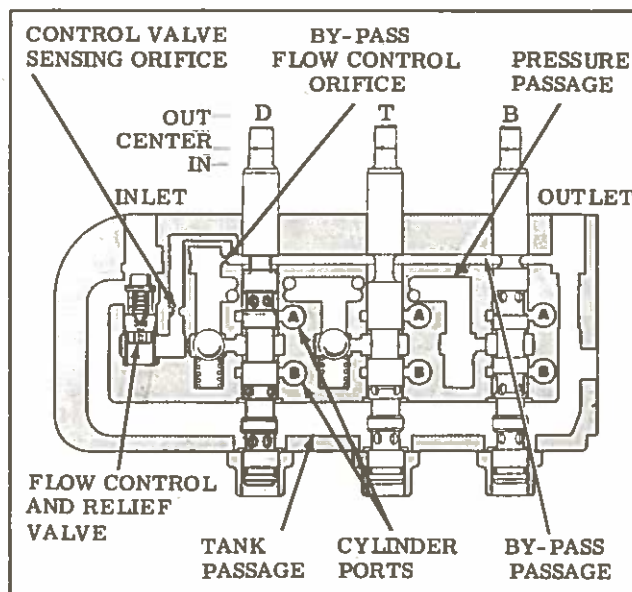


Figure 2

(c) K* Section - The K* section is essentially the same as the R* section except it has a full by-pass feature.

2. Outlet Sections

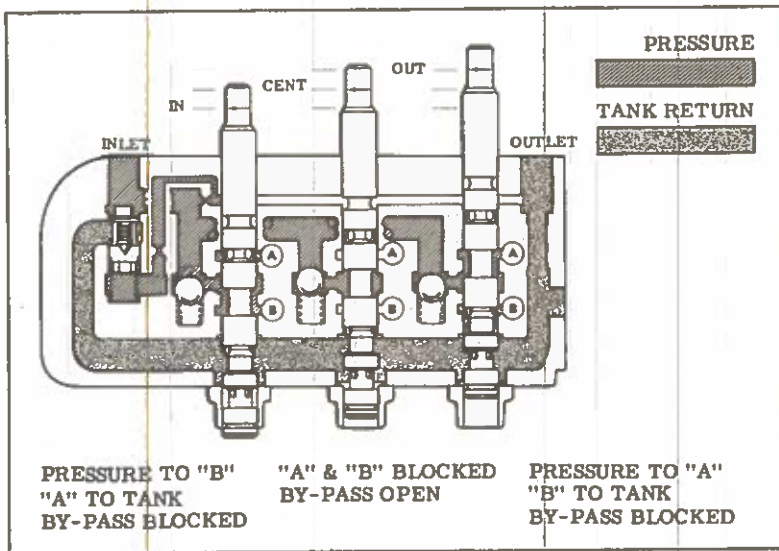
(a) *L Section - When two or more spools are required in a valve bank, the last section will be an *L section. The "*" denotes the spool type. This section contains the exhaust oil port and also is built to accept a check valve to prevent back flow when this feature is required.

(b) *E Section - This section is used for tandem operation by providing an outlet connection through which the by-pass feature for pump unloading is extended on to a subsequent valve bank. It is used in conjunction with an "F*" type inlet section in the next valve bank. Like the *L section it contains an operating spool and is built to accept a check valve to prevent back flow when this feature is required.

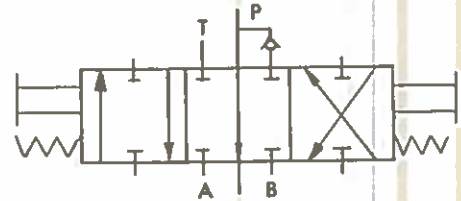
3. Spool Operation

Six standard spool designs are available (A, B, C, D, T and W). Any combination of spools may be used with a valve bank to perform a variety of operations. All operating spools are equipped with centering springs which return the spools to neutral.

For convenience, U. S. A. S. I. symbols are shown with the following descriptions of each spool.

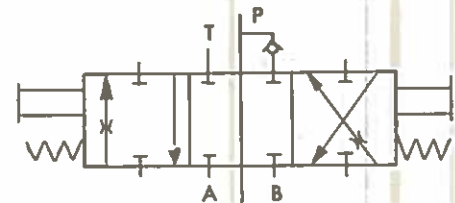
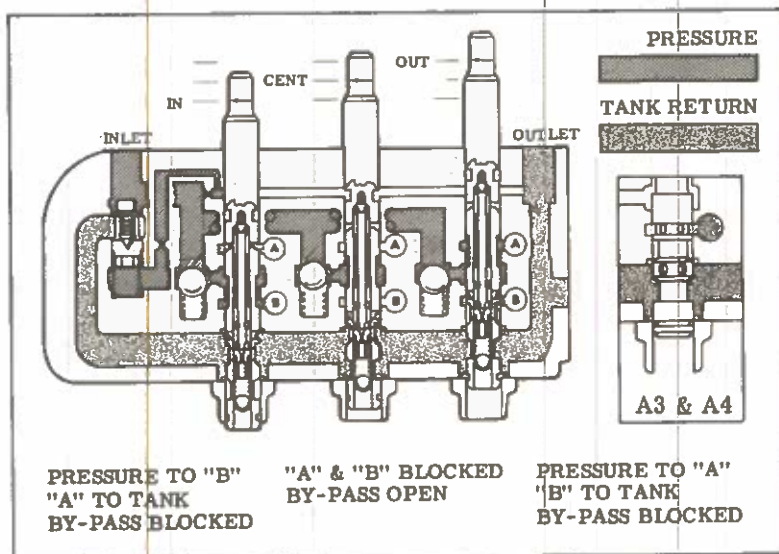


(a) "D" Double Acting Spool - "D" spools are used for applications where pump flow must be directed to either end of a cylinder, depending on the direction of movement required. The end of the cylinder not under pressure has its return flow directed to reservoir via internal coring of the valve sections. See Figure 3 for spool position versus flow.

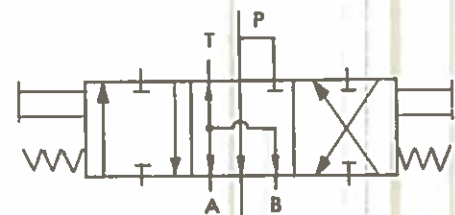
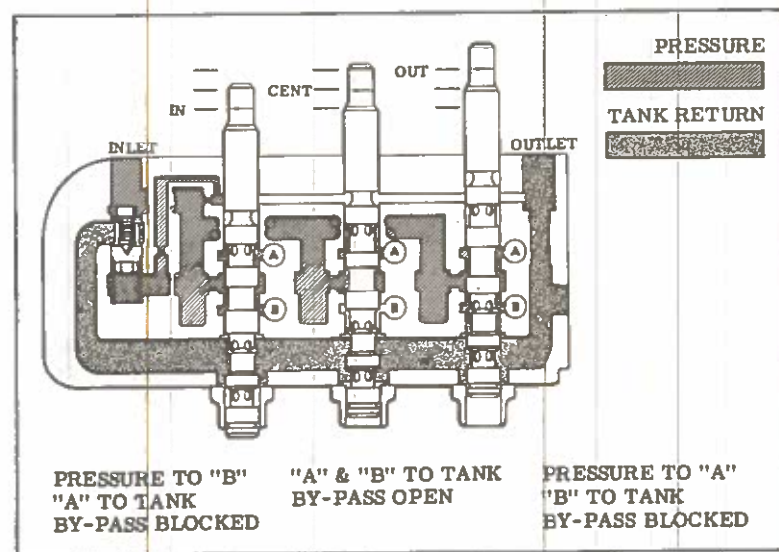


(b) "A" Double-Acting Spool - The "A" spool is a double-acting spool with variable orifices. An internal spool is used to provide this variable restriction. So long as there is a positive inlet pressure, the orifice is large, permitting unrestricted return flow. Decreased inlet pressure permits the spool to shift, decreasing the orifice size.

(c) "A3" and "A4" Spools - These are double-acting spools with fixed orifices to restrict flow to the reservoir from either cylinder port (see Figure 4). This prevents losing control of the load. Operation is otherwise the same as the "D" spool. See sub-paragraph (a) above.



(d) "B"-Motor Spool - "B" spools are used when flow is directed to the operation of a hydraulic motor instead of a cylinder. These spools are double acting in character so that the motor may be rotated in either direction. The cylinder ports are left partially open in the neutral position to allow free flow of oil between the motor and reservoir. Check valves are not used in "B" spools. See Figure 5 for spool position vs. flow characteristics.



(e) **"C" Float Spool** - "C" spools are double acting with an additional float position. The spool is retained in the float position by a detent, and it is spring centered to neutral from the "in" and "out" positions. Both cylinder ports are open to the reservoir in the float position to permit free flow of oil in either direction. See Figure 6 for spool position versus flow.

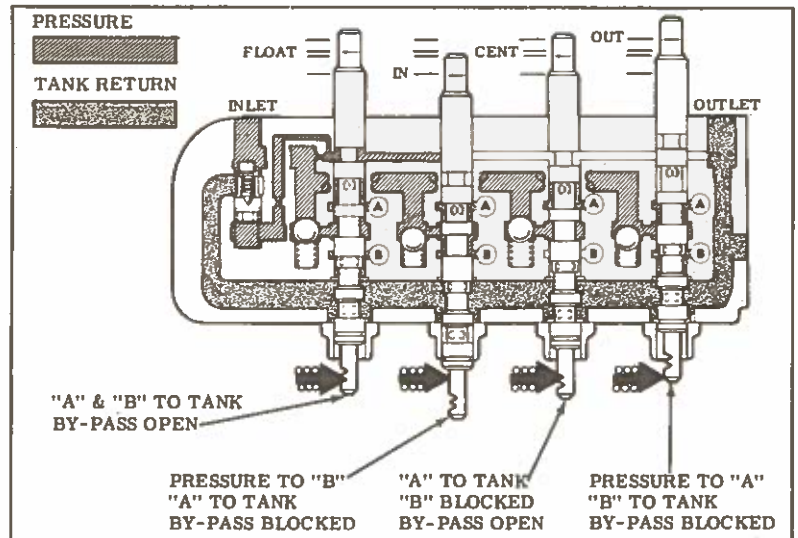
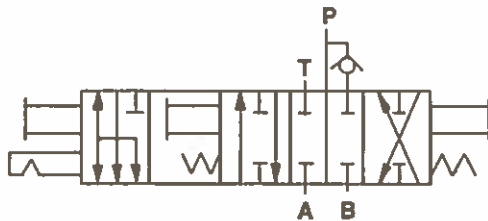


Figure 6 "C" FLOAT SPOOL

(f) **"T" Single Acting Spool** - "T" spools direct flow to one end of an operating cylinder only as in the example of the lift mechanism on a fork-type truck. Return flow is from the same end of operating cylinder and relies on gravity or mechanical means. Flow is controlled to and from port B. Port A is plugged. See Figure 7 for spool position versus flow.

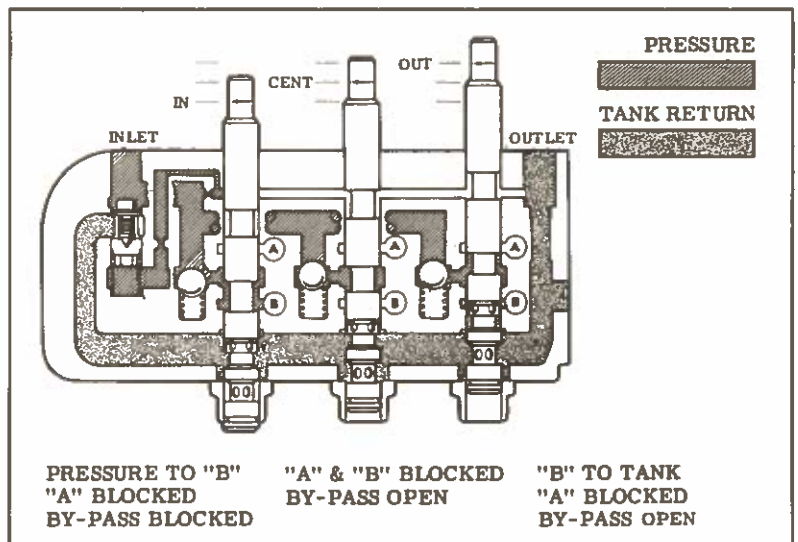
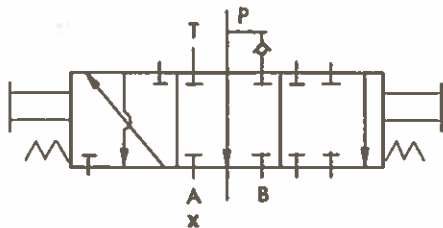


Figure 7 "T" SINGLE ACTING SPOOL

(g) **"W" Single Acting Spool** - The "W" spool is a single-acting spool which operates the reverse of the "T" spool explained above. Flow is controlled to and from port A, and port B is plugged.

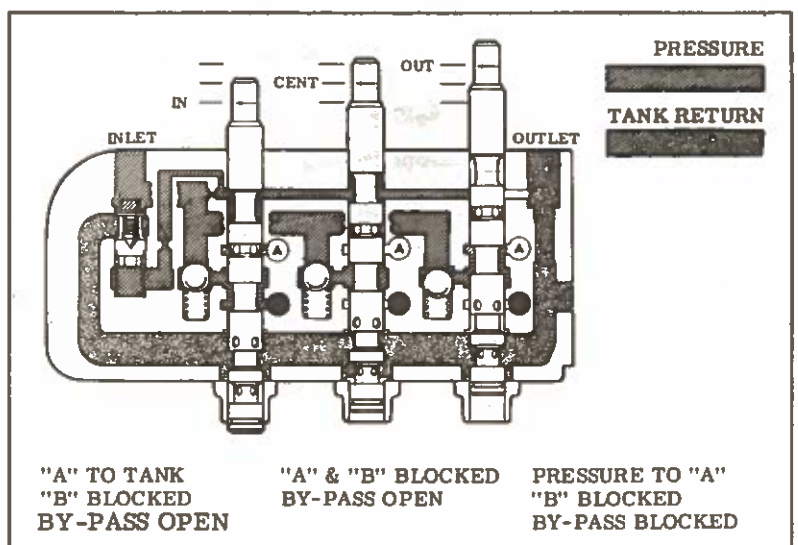
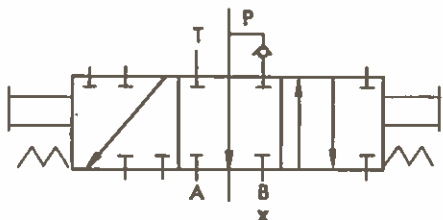


Figure 8 "W" SINGLE ACTING SPOOL

4. Flow Control and Relief Valve

Earlier design valves were equipped with simple relief valves in the inlet sections. The partial flow by-pass system in the CM11-21 valve makes use of a compound type flow control and relief valve arrangement.

By sensing the pressure drop across an orifice at the entrance to the by-pass, the valve acts as a flow control to limit flow through the by-pass to approximately seven gallons per minute. The balance of the pump delivery is diverted through the reservoir passage. This arrangement greatly reduces pressure drop through the valve in the neutral position.

When a spool is shifted to operate a portion of a machine, the flow control is inoperative and full pump volume is available to the system. The control valve then functions as an overload relief valve. System pressure is limited to a prescribed maximum by the action of this valve. Inlet body type "F" (Table I), is not equipped with a relief valve. Full pump volume is available to the system at all times.

(a) **Flow Control** - Figure 2 shows the valve operation in neutral with flow in excess of seven gpm. Flow across the by-pass orifice results in a pressure drop. The decreased pressure is sensed at the spring end of the valve sub-assembly through a sensing orifice. The slightly higher pressure at the other end of the valve permits it to shift down, diverting excess flow to the reservoir passage. With flow less than seven gpm, there would be negligible pressure drop across the by-pass orifice. Then the control valve would be held closed by the large spring and all flow would be through the by-pass passage.

(b) **Relief Valve** - Operation of the relief valve feature is shown in Figure 9. When an operating spool is shifted, fluid is ported into the system and the by-pass is blocked.

Figure 9A shows operation at less than the relief valve setting. There is no flow over the by-pass orifice, so full system pressure is sensed at the spring end of the control valve, as well as the opposite end. The valve is thus hydraulically balanced and the large spring holds the relief valve spool closed.

Maximum pressure is determined by the setting of the small spring inside the control valve assembly. When system pressure is high enough to overcome this heavy spring, the poppet is forced off its seat. (See Figure 9B.) Fluid immediately flows past the poppet to the tank passage. This flow creates a pressure drop across the sensing orifice and the control valve is no longer hydraulically balanced. When pressure drop across the sensing orifice is great enough to overcome force of the large spring, the valve spool shifts, permitting flow to the tank passage.

5. **Check Valves** - Timing of the valve spools is such that one cylinder port opens to pressure and the other port opens to reservoir before the by-pass passage is completely blocked. To prevent return

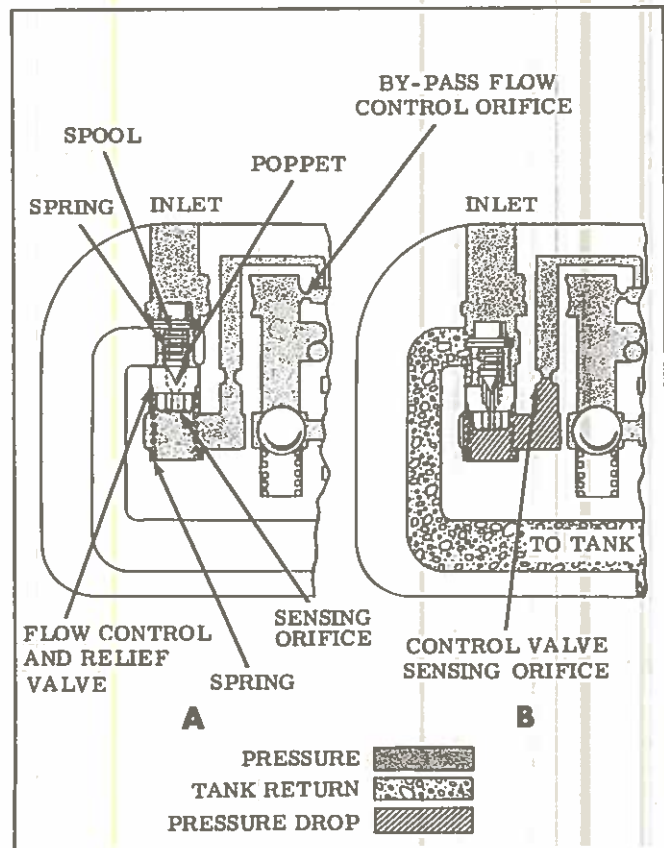


Figure 9

flow from a cylinder port from passing into the pressure passage and escaping through the partially closed by-pass, check valves are provided in each operating section except sections with "B" spool. The check valves prevent the load from dropping.

6. **Detent** - The spool detent consists of a special end cap with a spring loaded plunger. The plunger engages in a groove in the spool extension and holds the spool in the desired position.

7. **Tandem Operation** - Tandem operation permits operation of two banks of valves from the same pumping source. An internal plug in the outlet section of the first bank (Figure 10) separates the by-pass passage from the tank passage. Cylinder exhaust oil is returned to tank via the alternate discharge port, and by-pass oil is directed out the primary discharge port to the by-pass port of the bank.

In Figure 10, either bank can be operated separately or both simultaneously. This is possible because of the tandem by-pass connection from the inlet connection of the first bank to the F inlet connection of the second bank. If neither bank is operating, part of the fluid flows through both by-pass passages directly to reservoir. The balance is diverted through the tank passage of the first section as shown in Figure 2.

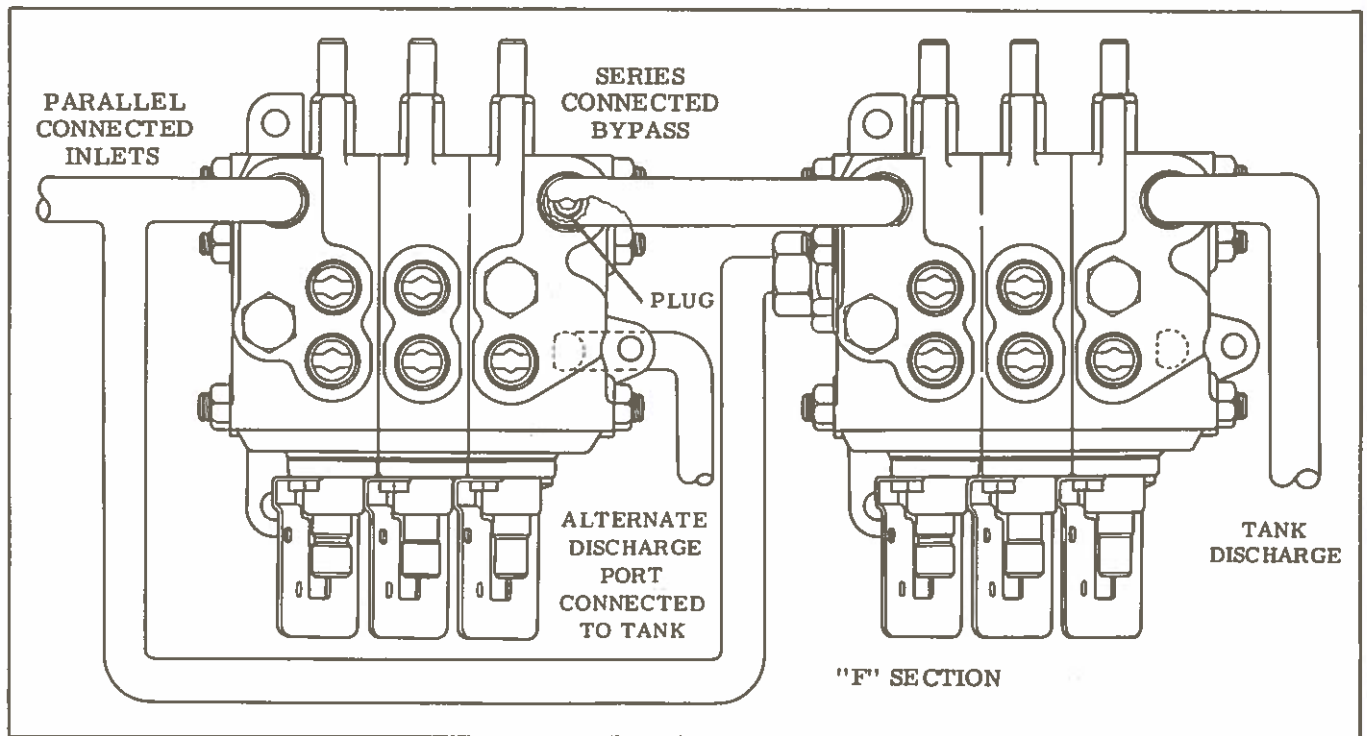


Figure 10

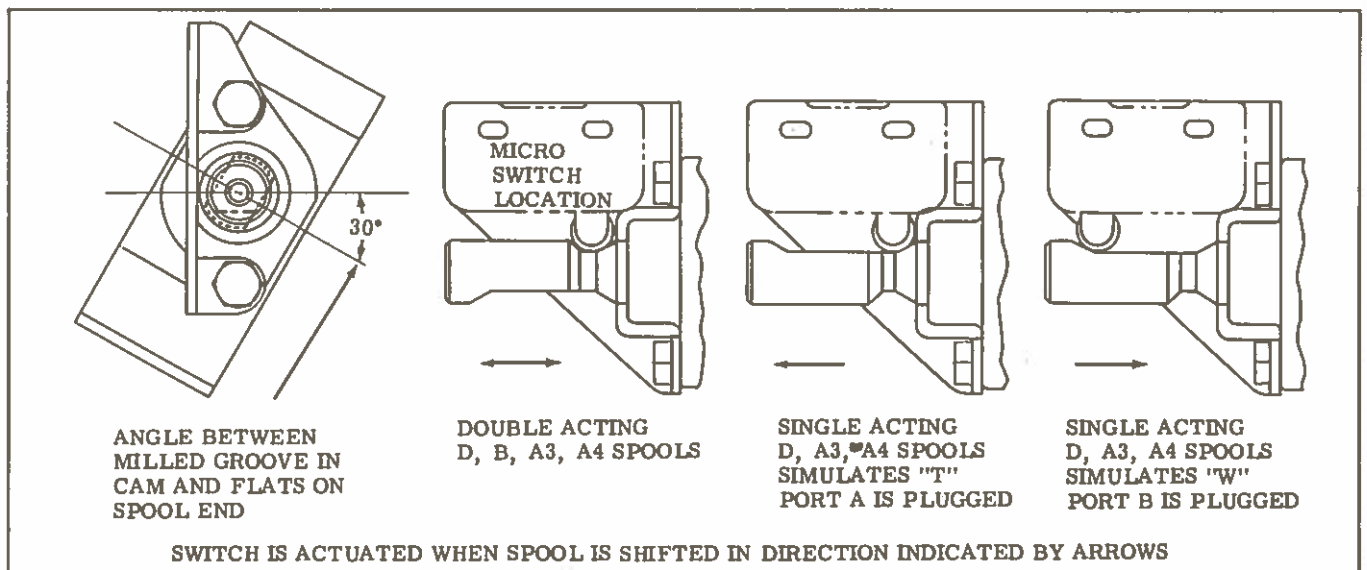


Figure 11

In some cases, it is desirable to have tandem valves connected in series where the second bank is dependent upon the operation of the first bank. The first bank has control priority because the tandem by-pass connection is not used. The cylinder by-pass oil of the first bank is directed out of primary discharge port to the inlet port of the second bank. Use a "K" inlet section in the first bank if full flow is desired to the second bank. Otherwise reduced flow will be encountered.

8. Electric Switch Section - Provision is made to actuate a switch to start the hydraulic power source on electric powered machines only when it is needed. For "T" spool operation, the "A" port must be plugged. "W" spool operation requires that port "B" be plugged.

All D, T or W electric limit switch models are supplied with "D" spools only. "T" or "W" spool operation is accomplished by mounting the switch or rotating the spool extension as shown in Figure 11.

9. Narrow By-Pass Sections - Narrow by-pass sections have narrower by-pass grooves in the spools. These provide better metering for low volume applications.

C. NON-OPERATING SECTIONS

The CM11-21 valve non-operating sections are the "E" and "L" outlet sections. These sections do not have operating spools. The functions of these sections are as follows:

1. "E" Outlet Section - The "E" type section provides an outlet section by which the by-pass feature for pump unloading is extended to a subsequent valve bank (tandem operation). It is generally used

in conjunction with the "F" type inlet section on the subsequent valve bank assembly. This "E" type section is only used with one-spool banks.

2. "L" Outlet Section - The "L" type section is basically the same section as the "E" section except it provides only one connection for exhaust oil and is used as the last section on a single-spool bank where tandem operation is not required.

NOTE

It should be noted that the pressure drop across the valve, when used in series operation, will be the sum of the pressure drops for each section.

SECTION IV - INSTALLATION AND OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS

Installation drawing 303 should be consulted for installation dimensions.

B. MOUNTING

These valves can be mounted in any position. Enough clearance must be left to provide access to the port connections and to permit actuating the control mechanism. The valves should be securely bolted to the mounting surface.

NOTE

Valves should be mounted on a relatively flat surface to prevent possible distortion of the valve bodies.

C. PORT CONNECTIONS

Except for the alternate discharge port, all connections are compatible with standard SAE fittings and "O" ring seals. It is only necessary to tighten fittings so that there is a firm metal-to-metal contact.

D. RELIEF VALVE

Relief valve sub-assemblies in the inlet section are preset and tested by Vickers for given pressure settings. Selection of the relief valve setting is based on the work requirements of the system. If a different relief valve setting is required, the valve sub-assembly should be replaced.

E. TANDEM INSTALLATION

1. Port connections for tandem series operation are shown in Figure 10.

2. The outlet section of the first bank must be an "E" section which is equipped with a plug (see Figure 10) to block the primary discharge port from the reservoir. The alternate discharge port must be connected to the reservoir.

NOTE

Slight leakage past the internal plug is permissible. The plug should not be tightened excessively, as there is the danger of distorting the body and causing the spool to bind.

F. MICRO-SWITCH AND CAM INSTALLATION

1. Figure 11 illustrates the correct mounting positions for the micro-switch, bracket and cam.

2. To convert a standard section to an electric switch section, the end cap screws must be removed to attach the bracket. The cam must be pressed into the spool at the correct angle with the flats on the spool end as shown in Figure 11. Secure cam in spool with a good grade of epoxy adhesive.

CAUTION

Use caution while inserting cam into spool to avoid damaging nylon cam.

G. HYDRAULIC TUBING

1. The number of bends in tubing must be kept to a minimum to prevent excessive turbulence and friction of oil flow.

2. Tubing must not be bent too sharply. The minimum radius for bends is three times the inside diameter of the tube.

3. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

4. All tubing must be thoroughly cleaned before installation to remove dirt, rust and scale. Recommended methods of cleaning are sand blasting, wire brushing and pickling.

NOTE

For instructions on pickling, refer to Vickers Instruction Sheet M-9600.

H. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL

The oil in a hydraulic system serves as the power transmission medium. It is also the system's lubricant and coolant. Selection of the proper oil is a requirement for satisfactory system performance and life. Oil must be selected with care and with the as-

sistance of a reputable supplier.

Refer to Vickers oil recommendations for mobile hydraulic systems, data sheet M-2950-S.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers sales representative.

SECTION V - SERVICE, INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

No special tools are required to service Vickers CM11-21 series, multiple unit valves.

B. INSPECTION

Periodic inspection of spool operation, oil condition and pressure connections saves time-consum-

TABLE III - TROUBLE, CAUSE AND REMEDY CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Oil leaks at either end of spool. Spring-centered spools do not return to neutral.	Defective "O" rings in valve body.	Replace "O" rings.
	Broken springs.	Replace springs.
	Bent spool.	Replace with new section of same size and type.
	Foreign particles.	Clean system and valve.
	Misalignment of operating linkage.	Check linkage for binding condition.
	Valve bank improperly torqued.	Retorque nuts to specified ratings.
Detent type spools will not stay in detent position.	Worn detent barrel.	Replace detent barrel.
	Weak or broken detent spring.	Replace detent spring.
No motion, slow or jerky action of hydraulic system.	Relief valve not properly set, or stuck in base and/or worn.	Repair, clean and readjust.
	Dirt or foreign particles lodged between relief valve control poppet and seat.	Disassemble, clean and reassemble.
	Valve body cracked inside.	Replace valve section.
	Spool not moved to full stroke.	Check travel.
No relief valve action (high pressure).	Small particle of dirt plugging orifice in relief valve sub-assembly.	Remove relief valve and check hole. If blocked, clear hole.
	Relief valve sub-assembly installed backwards.	Install properly.
Load will not hold.	Oil bypassing between spool and body.	Replace valve.
	Oil bypassing piston in cylinder.	Repair or replace cylinder.
	Spool not centered.	Refer to above spool remedies.
Load drops when spool is moved from neutral to a power position.	Dirt or foreign particles lodged between check valve ball and seat.	Disassemble, clean and reassemble.
	Scored or sticking check valve.	Replace poppet.

ing breakdowns and unnecessary parts replacement.

1. All hydraulic connections must be tight. Loose connections not only allow leakage, but also permit air to be drawn into the system, resulting in noisy and erratic operation.

2. Spools should return to neutral automatically when the control is released. The standard centering spring force is approximately 28 pounds with the spool in the neutral position, and approximately 56 pounds with the spool in the shifted position. If more force is necessary, the spool may be binding or control linkage may be faulty.

3. System filters and reservoir should be checked periodically for foreign particles. If excessive contamination is found, the system should be drained. The reservoir must be cleaned thoroughly before refilling.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to the system, it should be pumped through a 25 micron filter. If such a filter is not available, or practical to use in the field, a funnel with a fine wire screen (200 mesh or better) can be used.

SECTION VI - OVERHAUL

A. GENERAL

During disassembly, particular attention should be given to identification of parts for reassembly. Spools are selectively fitted to valve bodies and must be returned to the same bodies from which they were removed. Valve sections must be reassembled in the same order.

Figure 12 is an exploded view showing the proper relationship for reassembly. Reference is made to these figures in the procedures which follow.

B. DISASSEMBLY

1. Controls - Be sure the unit is not subjected to pressure. Disconnect and cap all lines and disconnect linkage to the spool. If hand levers are used, remove the "E" washers which retain the fulcrum rod and remove the rod, levers and pivot pins.

2. Attaching Parts - Remove the four tie studs and nuts and separate the valve sections. Be careful not to destroy or lose spacers.

3. End Caps - On CM11-21 models remove the micro-switch from the bracket. Remove the two screws which secure the spool end cap and remove the cap (and switch bracket, if used). If the cap has a detent assembly, screw out the detent plug

It is important that oil be clean and free of all substance which will cause improper operation and excessive wear of the pump or other hydraulic units in the system. Be sure to purge all air from the system.

D. LUBRICATION

Internal lubrication is provided by system oil.

E. REPLACEMENT PARTS

Only genuine parts manufactured or sold by Vickers should be used as replacement parts for these valves. Only Vickers knows the true quality level required of each part. These are listed in the applicable parts catalogs, copies of which are available on request.

F. TROUBLESHOOTING

Table III lists the difficulties which may be experienced with the unit and hydraulic system. It indicates the cause and remedy for each of the troubles listed. It should always be remembered that pressure and delivery are factors which are usually dependent upon each other. Adequate pressure gage equipment and a thorough understanding of the operation of the complete hydraulic system are essential to diagnose improper operation.

and remove the spring and piston. Remove the "O" ring from the cap.

4. Operating Spool - Slide the spool out of its bore and remove the "O" rings from the groove in the spool and from the valve body around the spool bore. Do not remove the centering spring, retainers or the spool extension unless it is necessary to replace them.

5. Check Valve - Grip the stem of the check valve plug with pliers and pull it out of the valve body. Remove the "O" ring and back-up ring. Remove the spring and ball from the valve body.

6. Relief Valve Sub-Assy - Screw out the plug which retains the relief valve and remove the "O" ring from the plug. Remove the spring and the relief valve sub-assembly. In F* sections, remove the solid plug.

7. Valve Body - Remove the plug and "O" ring from the blocked cylinder port on models with a single acting spool. If the alternate discharge port is plugged, it is not necessary to remove the plug unless the body is to be replaced. On F* bodies, remove the fitting, "O" rings and back-up ring.

C. CLEANING, INSPECTION AND REPAIR

1. Discard all old seals. Wash all parts in a

clean mineral oil solvent and place them on a clean surface for inspection.

2. Carefully remove burrs by light stoning or lapping. Be certain there is no paint or burring on mating surfaces of valve bodies.

3. Inspect the valve spools and bores for burrs and scoring. If scoring is not deep enough to cause objectionable leakage, the surfaces can be stoned or polished with crocus cloth. If scoring is excessive, the valve body and spool must be replaced. Check the valve spool for freedom of movement in the bore.

4. Check the relief valve for smooth movement in its bore. The valve should move from its own weight.

D. ASSEMBLY (Figure 12)

NOTE

Coat all parts with clean hydraulic oil to facilitate assembly and provide initial lubrication. Petroleum jelly can be used to hold seal rings in place on assembly.

1. Valve Body - On models with single-acting spool, install the "O" ring on the port plug and plug the appropriate cylinder port. Tighten the plug securely, but DO NOT over tighten. On F* models, install the back-up ring and then the "O" rings on the fitting. Tighten the fitting securely, but DO NOT over tighten.

CAUTION

Hex head of relief valve must face outside of unit.

2. Relief Valve - Install the "O" ring on the relief valve plug. Place the relief valve assembly in its bore, HEX NUT END UP. Install the spring and plug and tighten the plug securely but DO NOT over tighten.

3. Check Valve - Install a new back-up ring and

"O" ring on the check valve plug with the "O" ring toward the spring and ball. Place the ball and spring in the body and install the plug. Be sure the hole in the plug lines up with the stud hole in the body. Check valves are not used in "B" spool sections.

4. Operating Spool - If the centering spring was removed, install the spring and retainers on the spool. Place the "O" ring in the groove around the spool bore and install the "O" ring on the spool. Install the spool in the bore. On electric switch models, be certain the cam extension is in the correct position.

5. End Cap - Install the "O" ring in the end cap groove and install the cap, switch bracket (if used) and attaching screws. Torque the screws securely. On models with detents, grease all the detent parts. Install the end cap and check for proper spool extension alignment. Install the piston, spring and plug. Be sure to screw the plug in all the way.

6. Assembly of Unit

CAUTION

Make sure all mating surfaces of valve bodies are free of burrs and paint.

Install seal rings and the seal ring retainer in the grooves in the body of each inlet and center section. Use petroleum jelly to hold the seals in place. Carefully place the sections together in the same order in which they were removed. Coat the stud threads with "Loctite" or similar sealant and install the studs. Tighten the nuts to 17 pounds foot torque. If levers are used, install pins in each spool and assemble the levers, fulcrum rod and "E" washers.

SECTION VII - TESTING

Vickers, Incorporated application engineering personnel should be consulted for recommendations on test stand circuit requirements and construction. If test

equipment is available, valves should be tested at the recommended flow and pressure shown on installation drawing 303.



Figure 12



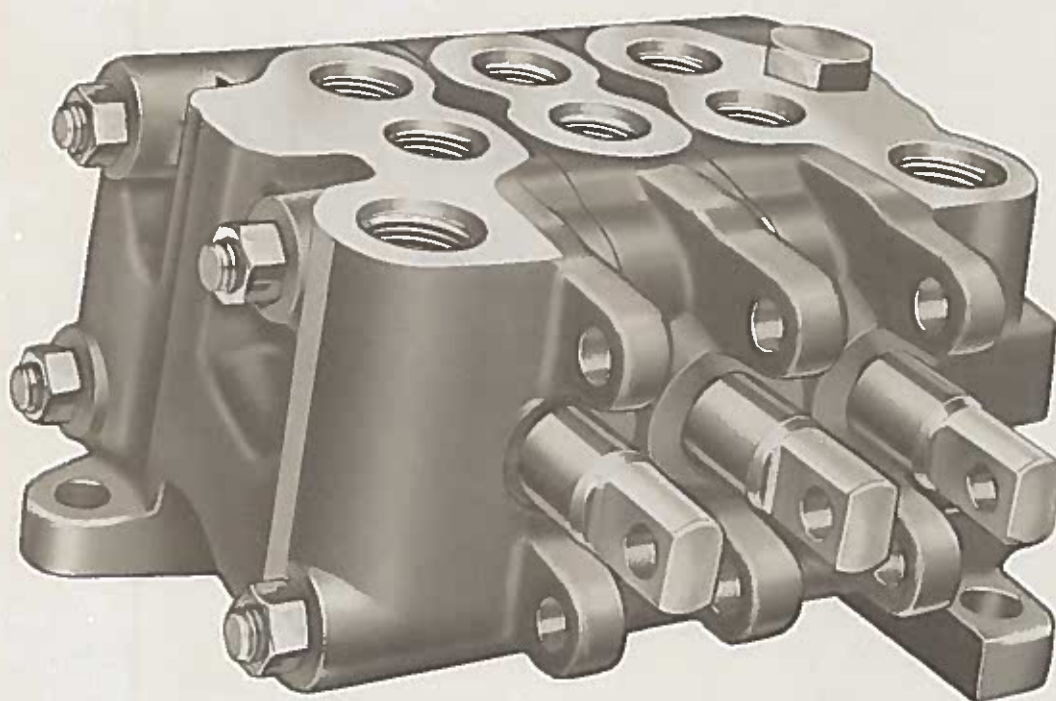
Litho in U. S. A.

Service Parts Information

**Multiple
Unit
Valves**

CM11 Series -21 Design

16



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

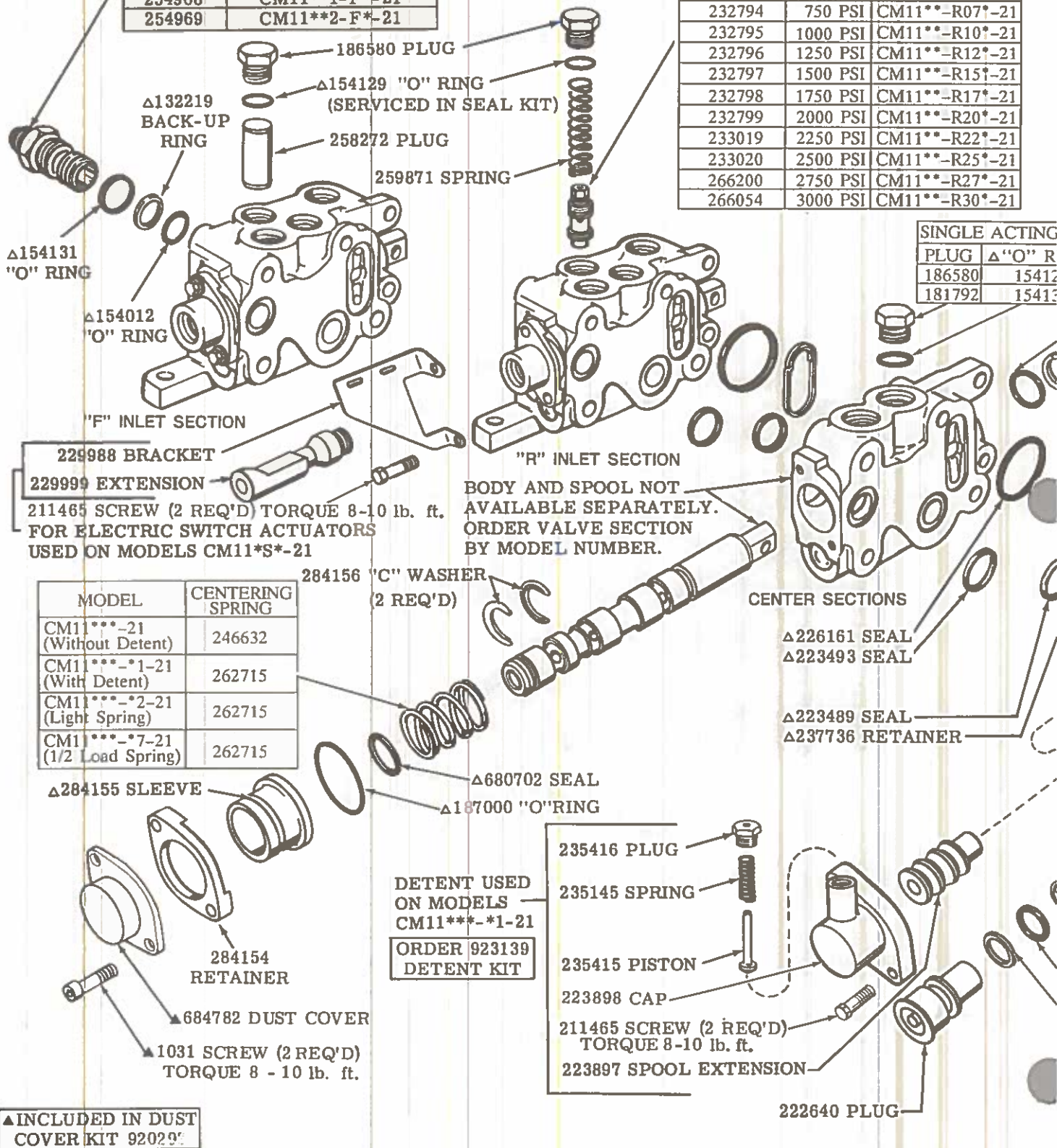
Revised 5-1-87

M-1729-S

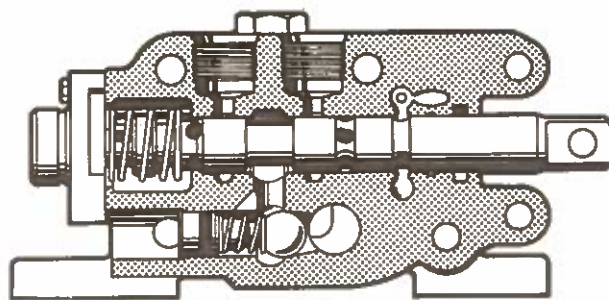
FITTING	PORT CONNECTION
254968	CM11**1-F*-21
254969	CM11**2-F*-21

CONTROL VALVE S/A	RELIEF SETTING	MODEL
233018	500 PSI	CM11**~R05*-21
232794	750 PSI	CM11**~R07*-21
232795	1000 PSI	CM11**~R10*-21
232796	1250 PSI	CM11**~R12*-21
232797	1500 PSI	CM11**~R15*-21
232798	1750 PSI	CM11**~R17*-21
232799	2000 PSI	CM11**~R20*-21
233019	2250 PSI	CM11**~R22*-21
233020	2500 PSI	CM11**~R25*-21
266200	2750 PSI	CM11**~R27*-21
266054	3000 PSI	CM11**~R30*-21

SINGLE ACTING	
PLUG	Δ"O" R
186580	15412
181792	15413

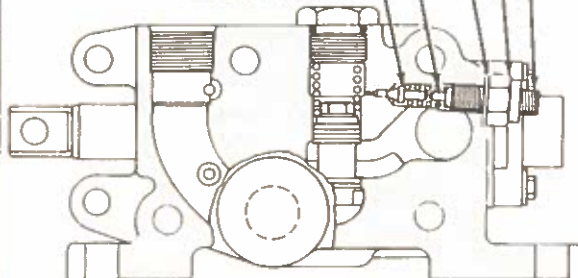


FULCRUM ROD	OVERALL LENGTH	MODEL	OPERATING SECTIONS
245491	1.766"	CM11-H1-20	1
245492	3.391"	CM11-H2-20	2
245493	4.891"	CM11-H3-20	3
245494	6.391"	CM11-H4-20	4
245495	7.891"	CM11-H5-20	5
245496	9.391"	CM11-H6-20	6
245497	10.891"	CM11-H7-20	7
245498	12.391"	CM11-H8-20	8
245499	13.891"	CM11-H9-20	9
245500	15.391"	CM11-H10-20	10



CM11NO*-R**V** Option

- 387802 SCREW
- AX-12123 NUT
- 266061 WASHER
- 175766 SPRING
- 387804 POPPET



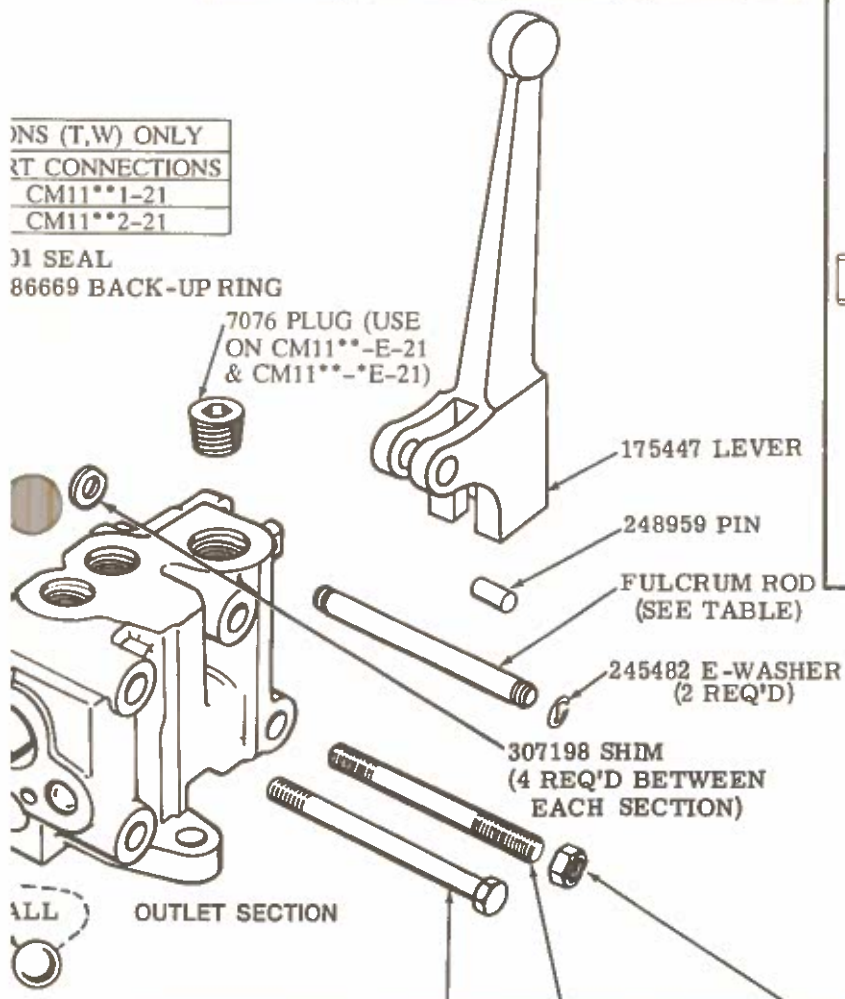
NOTE

Adjust 387802 screw to specified relief setting (V**) and tighten AX-12123 jam nut. (V**) value must be 250 PSI below (R**) value.

ONS (T,W) ONLY
RT CONNECTIONS
CM11**1-21
CM11**2-21

01 SEAL
86669 BACK-UP RING

7076 PLUG (USE
ON CM11**-E-21
& CM11**-*E-21)



175447 LEVER

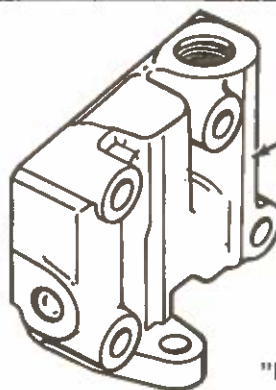
248959 PIN

FULCRUM ROD
(SEE TABLE)

245482 E-WASHER
(2 REQ'D)

307198 SHIM
(4 REQ'D BETWEEN
EACH SECTION)

OUTLET SECTION



CM11***-L-21
ORDER BY MODEL
NUMBER

"L" OUTLET SECTION

ΔINCLUDED IN
920278 SEAL KIT

F3 EQUIVALENT
SEAL KIT 923093

223388 SPRING

4008 "O" RING

271722 BACK-UP RING

SCREW (4 REQ'D)	STUD (4 REQ'D)	OVERALL LENGTH	NUT TORQUE 17 lb. ft.	MODEL	OPERATING SECTIONS
146835			1454	CM11-P1-20	1
214672			(4 REQ'D)	CM11-P2-20	2
	223153	7.38"	1454 (8 REQ'D)	CM11-P3-20	3
	223154	8.88"		CM11-P4-20	4
	223155	10.38"		CM11-P5-20	5
	223156	11.88"		CM11-P6-20	6
	223157	13.38"		CM11-P7-20	7
	223158	14.88"		CM11-P8-20	8
	223159	16.38"		CM11-P9-20	9
	223160	17.88"		CM11-P10-20	10

MODEL CODE BREAKDOWN

CM 11 * * * - * * * V * * * * * - 21

1
2
3
4
5
6
7
8
9
10
11

1 **Multiple Unit Control Valve**

2 **Series**

3 **Valve Bank Modification**

NO - No Modification
 ND - Standard Sections -
 Dust Covers
 NS - Standard Sections -
 Electrical Switch
 Actuators
 ZO - Narrow Bypass Sections
 - No Modification
 ZD - Narrow Bypass Sections
 - Dust Covers
 ZS - Narrow Bypass Sections
 - Electrical Switch
 Actuators

4 **Port Connections**

1 - 7/8-14 UNF - 2B
 Inlet & Discharge
 Ports -
 3/4-16 UNF - 2B
 Cylinder Ports
 2 - 1 1/16-14 UNF - 2B
 Inlet & Discharge
 Ports -
 7/8-14 UNF - 2B
 Cylinder Ports

5 **Inlet Body Type**

F - Carryover Port -
 No Relief Valve
 R - Standard - Relief Valve
 (Partial Flow Bypass)
 K - Standard - Relief Valve
 (Full Flow Bypass)
 J - Standard - Relief Valve
 (Partial Flow Bypass)

6 **System Relief Valve Setting - PSI**

05 - 500 PSI	17 - 1750 PSI
07 - 750 PSI	20 - 2000 PSI
10 - 1000 PSI	22 - 2250 PSI
12 - 1250 PSI	25 - 2500 PSI
15 - 1500 PSI	27 - 2750 PSI
	30 - 3000 PSI

7 **Adjustable System
Relief Valve Setting - PSI
(Omit if not required)**

V05 - 500 PSI	V17 - 1750 PSI
V07 - 750 PSI	V20 - 2000 PSI
V10 - 1000 PSI	V22 - 2250 PSI
V12 - 1250 PSI	V25 - 2500 PSI
V15 - 1500 PSI	

8 **Spool Type**

A6 - Counterbalance
 B - Motor
 C - Float
 D - Double Acting
 D3 - Dual Function
 D4 - Special Metering
 D5 - Combined &
 B Spool Functions
 T - Single Acting
 W3 - Safety Interlock

9 **Spool Modification
(Omit if not required)**

1 - Detent For Any Spool
 2 - Light Centering Spring
 7 - Half Load Centering Spring

10 **Outlet Body Type**

L - Standard
 E - Carryover Port
 E1 - E Section with
 Additional Outlet Port

11 **Design**

For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFF, OFR and OFRS filter series are recommended.

-LABORATORY WORK SHEET-

CM11, CM2, CM3 SERIES MULTIPLE UNIT VALVES

Name _____

I. PRELIMINARY OBSERVATION

A. Model number: _____

II. DISASSEMBLY

NOTE: During disassembly, particular attention should be given to identification of parts for reassembly. Spools are selectively fitted to valve bodies, and must be returned to the same bodies from which they were removed. Valve sections must be reassembled in the same order.

A. If hand levers are used, remove the "E" rings, levers, fulcrum rod, and links.

B. Remove the tie rod stud nuts and separate the valve sections.

1. Check condition of "O" rings:

Good _____ Worn _____ Damaged _____

2. What is the purpose of the shims between each valve section? _____

C. If end caps have detent assemblies, remove detent plugs, springs and detent pistons.

1. Remove two screws from end cap and remove end cap.

D. Slide spool out of bore from cap end.

1. Remove "O" rings from valve body and note condition:
Good _____ Worn _____ Damaged _____

2. Examine spring centering mechanism on end of spool.
O.K. _____ Replace _____

3. Place spool in lab cutaway valve section and note flow paths in center and shifted positions. Does spool agree with letter code in model number? _____

If a "T" spool, is proper cylinder port plugged?

E. Check valve removal.

1. Grip stem of check valve plug with pliers and pull it from valve body. Check condition of "O" ring and back-up ring:
Good _____ Worn _____ Damaged _____

2. Remove spring and poppet for examination.

F. Relief valve sub-assembly removal.

1. Remove relief valve retaining plug. Examine "O" ring:
 Good _____ Worn _____ Damaged _____

2. Remove spring and relief valve subassembly, or solid plug if an "F" section. What pressure setting is indicated in model number? _____ none ☐

G. Optional anti-cavitation check valve and cylinder port relief valves (omit if not applicable.)

1. Remove and examine.

III. CHECK DISASSEMBLY WITH INSTRUCTOR

IV. REASSEMBLY

A. Reassemble valve.

B. List missing parts: _____

V. SHOW THE GRAPHIC REPRESENTATION OF THE VALVE IN SYMBOL FORM:

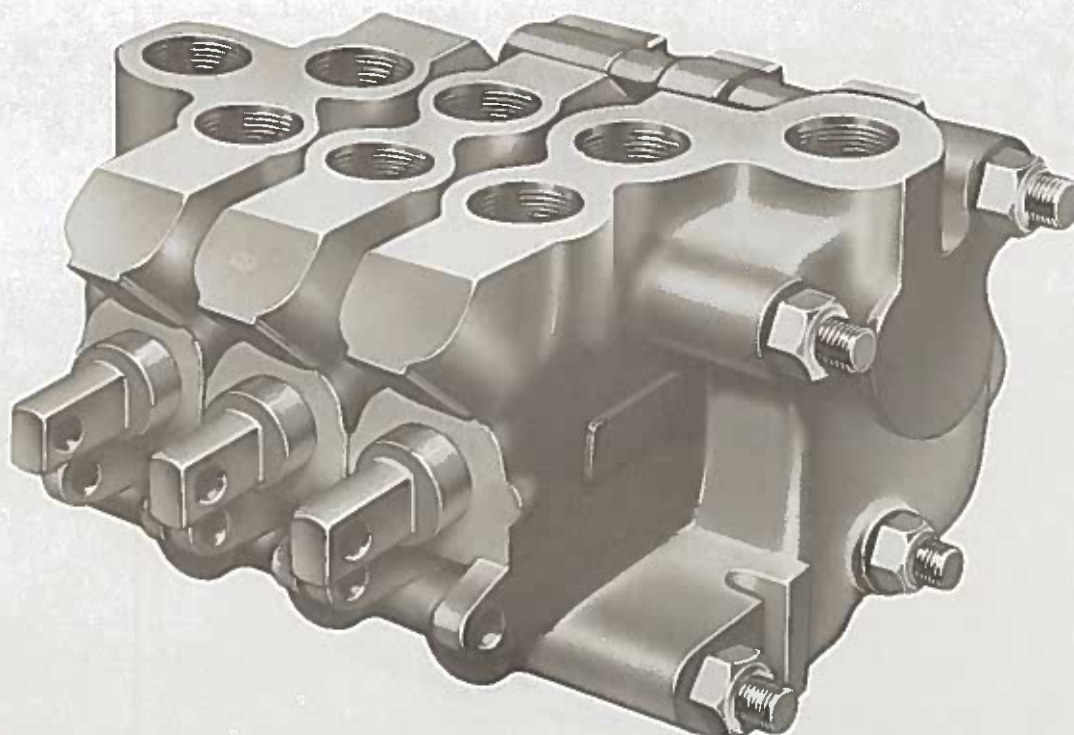
VI. CHECK WITH INSTRUCTOR

VICKERS

Service Parts Information

**Multiple
Unit
Valves**

CM2 Series -30 Design



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

Revised 11-1-86

M-2403-S

SPOOL MODIFICATION

"I" DETENT

"C" SPOOL FLOAT DETENT

- *235416 PLUG
- *238085 SPRING
- *235415 PISTON
- *249637 CAP

- *1250 SCREW
(2 REQ'D.)

- *1053 SCREW

- *249636 DETENT

- *242076 RETAINER

- *▲ 154018 "O" RING

- ▲ 199815 "O" RING
(1 REQ'D BETWEEN EACH SECTION)

- ▲ 170441 "O" RING
(4 REQ'D BETWEEN EACH SECTION)

- 1248 SCREW
(2 REQ'D)

- 257196 CAP

- 1050 SCREW

- 242079 GUIDE

- 206086 RETAINER—
(2 REQ'D)

BODY AND SPOOL
AVAILABLE SEP
ORDER SECTION
MODEL NUMBER

- 235416 PLUG (2 REQ'D.)
- 238085 SPRING (2 REQ'D.)
- 235415 PISTON (2 REQ'D.)
- 252509 CAP
- 237824 SNAP RING
- 252523 WASHER
- 1050 SCREW
- 206772 SPRING
- 252515 DETENT
- 1250 SCREW
(2 REQ'D.)
- 242079 GUIDE
- 206086 RETAINER
(2 REQ'D)

- 7078 PLUG
("E" SECTIONS ONLY)

- 262711 "E" RING
(2 REQ'D)

"L" SECTION

OUTLET SECTION

"U" SECTION

- 313695
BODY

- 307197 SHIM
(4 REQ'D BETWEEN
EACH SECTION)

CENTER SECTION

- 122546
RETAINING RING
(2 REQ'D)

- 261768 LEVER
SUB-ASSEMBLY

- 261342
LINK

FULCRUM ROD	LENGTH INCHES	OPERATING SECTIONS	LEVER KIT MODEL
262721	2.781	1	CM2-H1-30
262722	5.206	2	CM2-H2-30
262723	7.486	3	CM2-H3-30
262724	9.726	4	CM2-H4-30
262725	11.986	5	CM2-H5-30
262726	14.246	6	CM2-H6-30
262727	16.506	7	CM2-H7-30
262728	18.766	8	CM2-H8-30
262729	21.026	9	CM2-H9-30
262730	23.286	10	CM2-H10-30

BODY	MODEL DESIGNATION
313693	CM2NO1-L-30
313713	CM2NO2-L-30

CONTROL VALVE SUB-ASSY	RELIEF SETTING (PSI)	MODEL DESIGNATION
319693	500	CM2NO*-05*-30
319694	750	CM2NO*-07*-30
319695	1000	CM2NO*-10*-30
319696	1250	CM2NO*-12*-30
319697	1500	CM2NO*-15*-30
319698	1750	CM2NO*-17*-30
319699	2000	CM2NO*-20*-30
319700	2250	CM2NO*-22*-30
319701	2500	CM2NO*-25*-30

STUD KIT MODEL	OPERATING SECTIONS	STUD (4 REQ'D)	LENGTH INCHES
CM2-P1-30	1	280786	5.25
CM2-P2-30	2	242092	5.75
CM2-P3-30	3	242093	8.00
CM2-P4-30	4	242094	10.25
CM2-P5-30	5	242095	12.50
CM2-P6-30	6	242096	14.75
CM2-P7-30	7	242097	17.00
CM2-P8-30	8	242098	19.25
CM2-P9-30	9	242099	21.50
CM2-P10-30	10	242100	23.75

314657 PLUG
("F" SECTION ONLY)

313925 PLUG
("F" SECTION ONLY)

**ANTI-CAVITATION
CHECK VALVE**

313868 PLUG
("R" AND "K" SECTIONS ONLY)

▲184197 "O" RING
238834 SPRING

319962 PLUG
("R" SECTION ONLY)

7074 PLUG

267765 PLUG
("F" SECTION ONLY)

1458 NUT (4 REQ'D)
TORQUE 45-50 lb. ft.

**USED WITH CM2NO1-T-30
SPOOL SECTIONS**

194643 PLUG

184197 "O" RING

**ANTI-CAVITATION
CHECK WITH
CYLINDER PORT
RELIEF VALVE**

263632 CAP
154130 "O" RING
263506 SPRING

INLET SECTION

PORT RELIEF VALVE SUB-ASSY	RELIEF SETTING (PSI)	MODEL DESIGNATION
263601	750	CM2NO*-30-*07
263602	1000	CM2NO*-30-*10
263603	1250	CM2NO*-30-*12
263604	1500	CM2NO*-30-*15
263605	1750	CM2NO*-30-*17
263606	2000	CM2NO*-30-*20
263607	2250	CM2NO*-30-*22
263608	2500	CM2NO*-30-*25
294688	2750	CM2NO*-30-*27
263610	3000	CM2NO*-30-*30
263611	3250	CM2NO*-30-*32
263612	3500	CM2NO*-30-*35

CAUTION
THREAD STUDS FULLY
INTO OUTLET SECTION
BEFORE ASSEMBLING
VALVE.

▲154018 "O" RING

242075 POPPET

242789 SPRING

▲154010 "O" RING

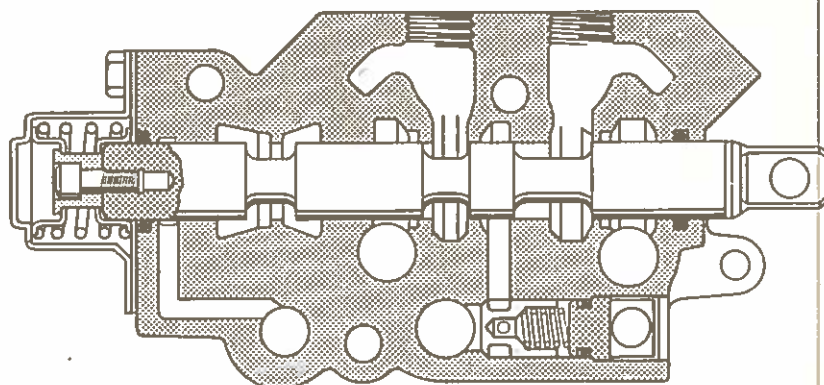
▲287146 BACK-UP RING

242074 PLUG

▲ INCLUDED IN
922926 SEAL KIT

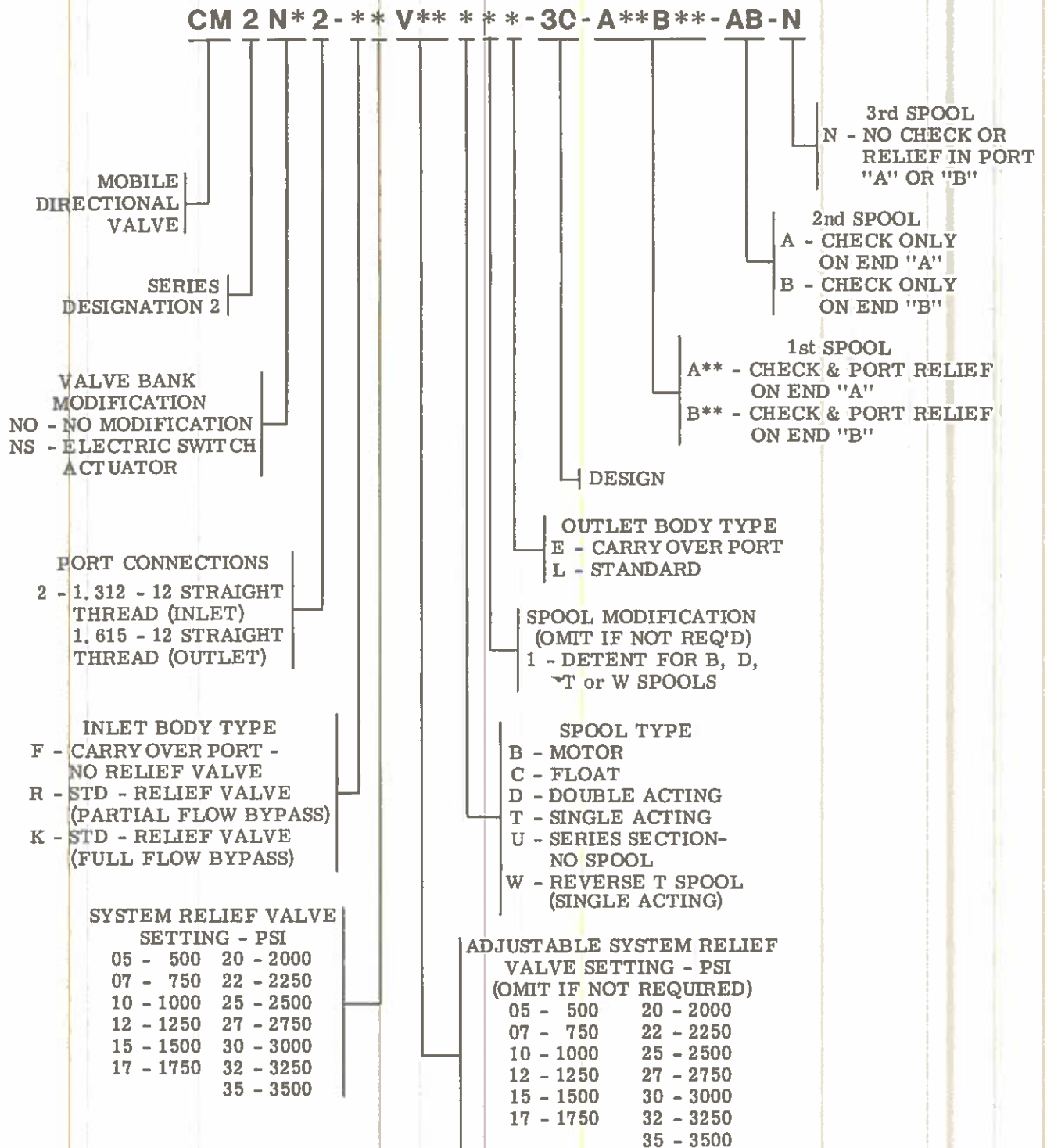
F3 EQUIVALENT
SEAL KIT 920124

*INCLUDED IN 923583
DETENT KIT



ASSEMBLY VIEW

MODEL CODE BREAKDOWN



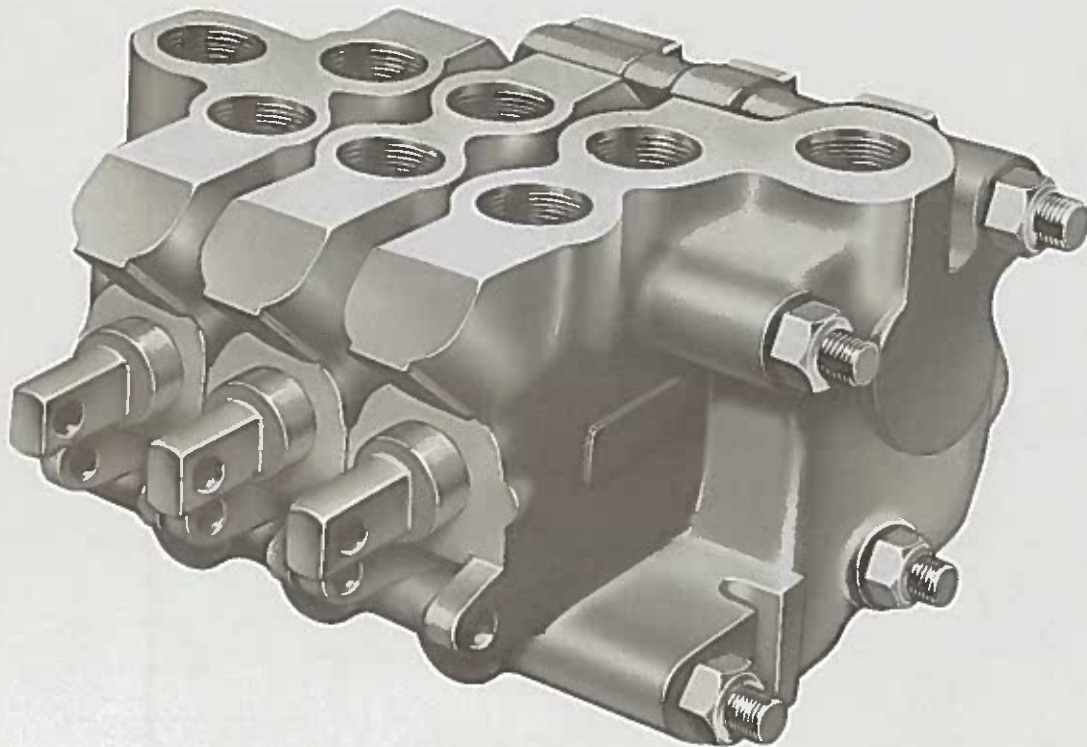
For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

VICKERS

Service Parts Information

**Multiple
Unit
Valves**

CM3 Series -30 Design



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

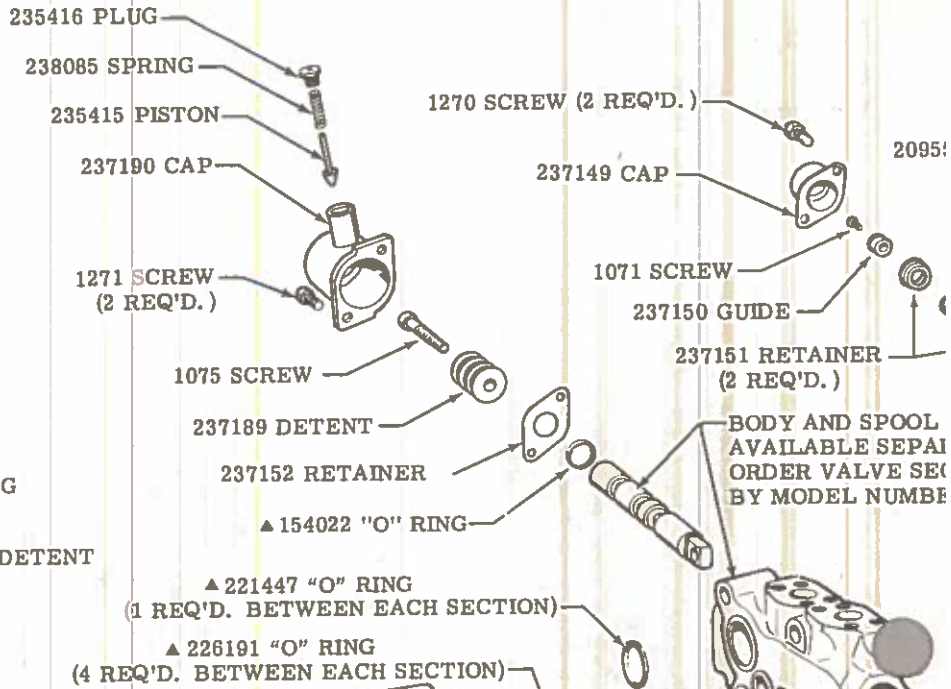
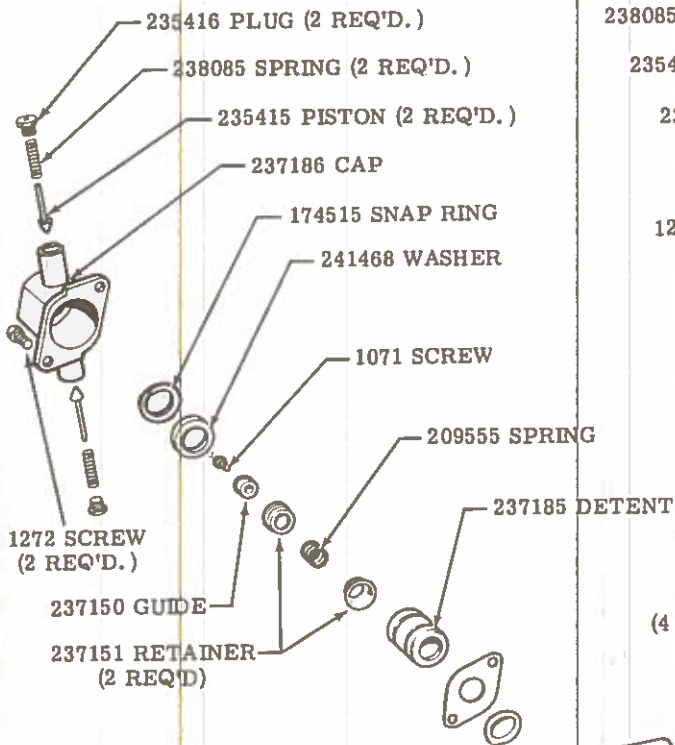
Revised 11-1-86

M-2404-S

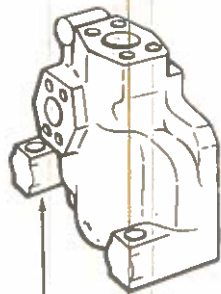
SPOOL MODIFICATION

"C" SPOOL FLOAT DETENT

"I" DETENT



7078 PLUG
("E" SECTIONS ONLY)

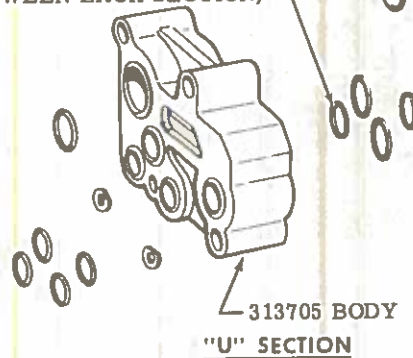


"L" SECTION

262711 "E" RING
(2 REQ'D.)

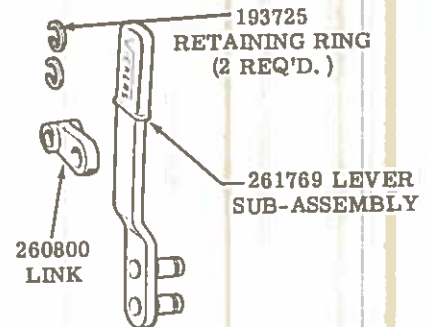


OUTLET SECTION



"U" SECTION

CENTER SECTION

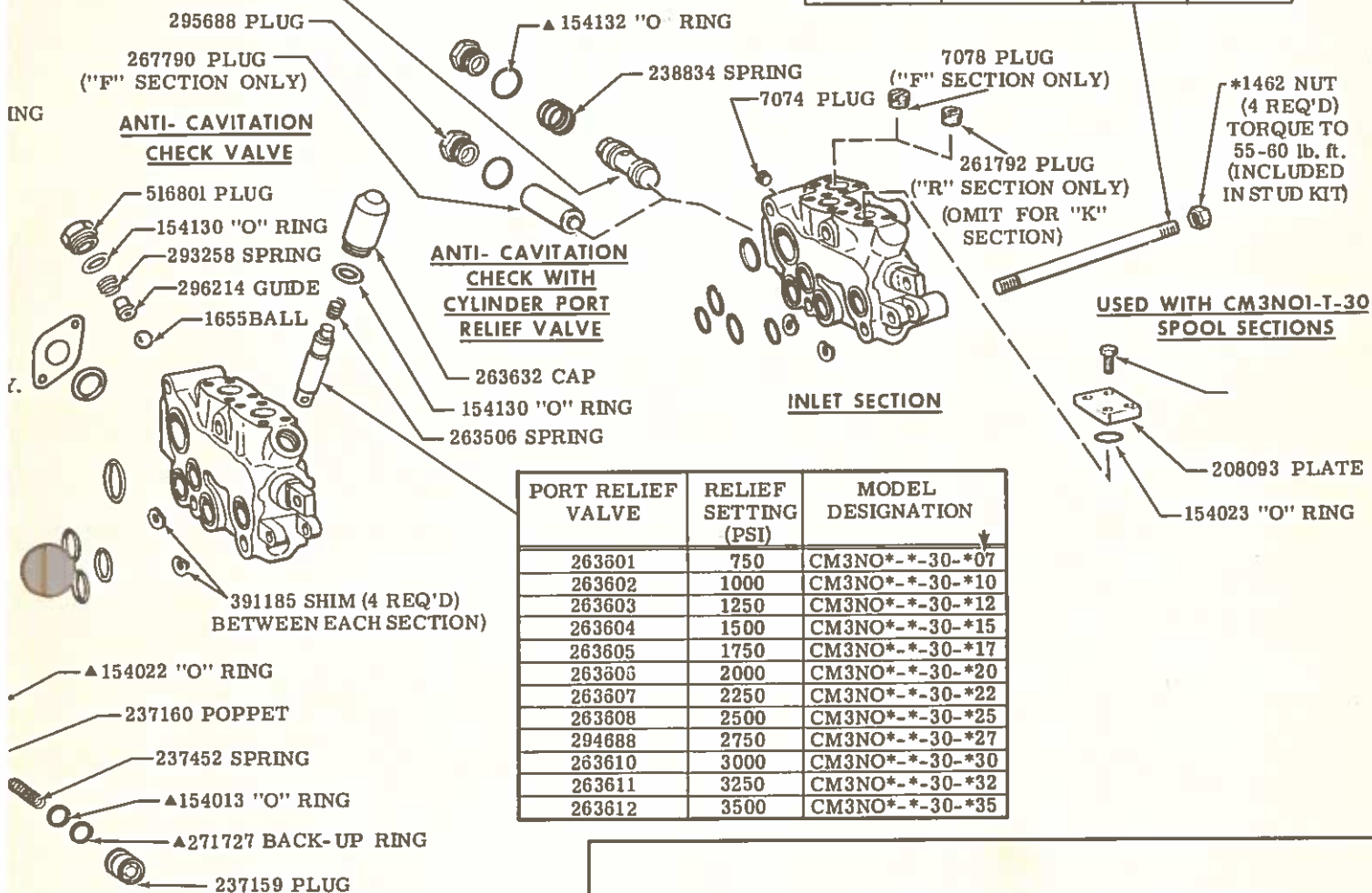


FULCRUM ROD	LENGTH (INCHES)	OPERATING SECTIONS	LEVER KIT MODEL
262721	2.781	1	CM3-H 1-30
263102	5.068	2	CM3-H 2-30
263103	7.568	3	CM3-H 3-30
263104	10.068	4	CM3-H 4-30
263105	12.568	5	CM3-H 5-30
263106	15.068	6	CM3-H 6-30
263107	17.568	7	CM3-H 7-30
263108	20.068	8	CM3-H 8-30
263109	22.568	9	CM3-H 9-30
263110	25.068	10	CM3-H10-30

BODY	MODEL DESIGNATION
313703	CM3NO1-L-30
313733	CM3NO2-L-30
313883	CM3NO4-L-30

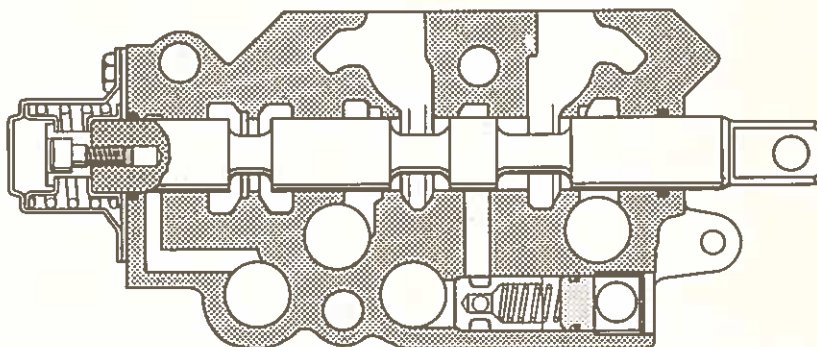
CONTROL VALVE SUB-ASSY	RELIEF SETTING (PSI)	MODEL DESIGNATION
233015	500	CM3NO*-05*-30
232836	750	CM3NO*-07*-30
232837	1000	CM3NO*-10*-30
233027	1250	CM3NO*-12*-30
232838	1500	CM3NO*-15*-30
232839	1750	CM3NO*-17*-30
232840	2000	CM3NO*-20*-30
233016	2250	CM3NO*-22*-30
233017	2500	CM3NO*-25*-30

*STUD KIT MODEL	OPERATING SECTIONS	*STUD (4 REQ'D)	LENGTH (INCHES)
CM3-P 1-30	1	280784	5.75
CM3-P 2-30	2	237172	6.25
CM3-P 3-30	3	237173	8.75
CM3-P 4-30	4	237174	11.25
CM3-P 5-30	5	237175	13.75
CM3-P 6-30	6	237176	16.25
CM3-P 7-30	7	237177	18.75
CM3-P 8-30	8	237178	21.25
CM3-P 9-30	9	237179	23.75
CM3-P10-30	10	237180	26.25



*THREAD STUDS FULLY INTO OUT-LET SECTION FIRST, THEN COMPLETE ASSEMBLY OF VALVE.

▲ = SERVICED IN SEAL KIT 922927



SEE SERVICE MANUAL M-2400-S FOR MAINTENANCE INFORMATION

MODEL CODE BREAKDOWN

CM 3 NO 1- * ** ***** 1 * -30-A**B**-**-(**)-N-B22

MULTIPLE UNIT
CONTROL VALVE
MOBILE

SERIES
DESIGNATION

VALVE BANK
MODIFICATION
NO - NO
MODIFICATION

PORT CONNECTIONS
1 - SAE 1 INCH 4-BOLT
FLANGE INLET &
CYLINDERS
SAE 1 1/4 4 - BOLT
FLANGE DISCHARGE

INLET BODY TYPE
F - CARRYOVER PORT - NO
RELIEF VALVE
K - STANDARD - RELIEF (FULL
FLOW BYPASS)
R - STANDARD - RELIEF VALVE
(PARTIAL FLOW BYPASS)

SYSTEM RELIEF
VALVE SETTING (P.S.I.)
05 - 500 12 - 1250 20 - 2000
07 - 750 15 - 1500 22 - 2250
10 - 1000 17 - 1750 25 - 2500

SPOOL TYPE
B - MOTOR
C - FLOAT
D - DOUBLE
ACTING
T - SINGLE
ACTING
U - SERIES
SECTION
(NO SPOOL)

DESIGN NUMBER
30 - 3rd DESIGN

OUTLET BODY TYPE
L - STANDARD
E - CARRY OVER PORT

SPOOL MODIFICATION
(OMIT IF NOT REQUIRED)
1 - DETENT FOR B, D, OR
T SPOOLS

5th SPOOL
B22 - CHECK AND
PORT RELIEF
SET AT 2250
P.S.I. IN "B"
PORT ONLY.
NOTHING IN
PORT "A".

4th SPOOL
N - NO CHECK OR
RELIEF VALVE
IN PORT "A"
OR "B"

3rd SPOOL
A22 - CHECK AND PORT
RELIEF SET AT
2250 P.S.I. ON END
"A".
B - CHECK ONLY ON
END "B"

2nd SPOOL
A - CHECK ONLY ON END "A"
B - CHECK ONLY ON END "B"

1st SPOOL
A** - CHECK AND PORT RELIEF
ON END "A"
B** - CHECK AND PORT RELIEF
ON END "B"
PORT RELIEF SETTING - P.S.I.
07 - 750 17 - 1750 27 - 2750
10 - 1000 20 - 2000 30 - 3000
12 - 1250 22 - 2250 32 - 3250
15 - 1500 25 - 2500 35 - 3500

For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U.S.A.

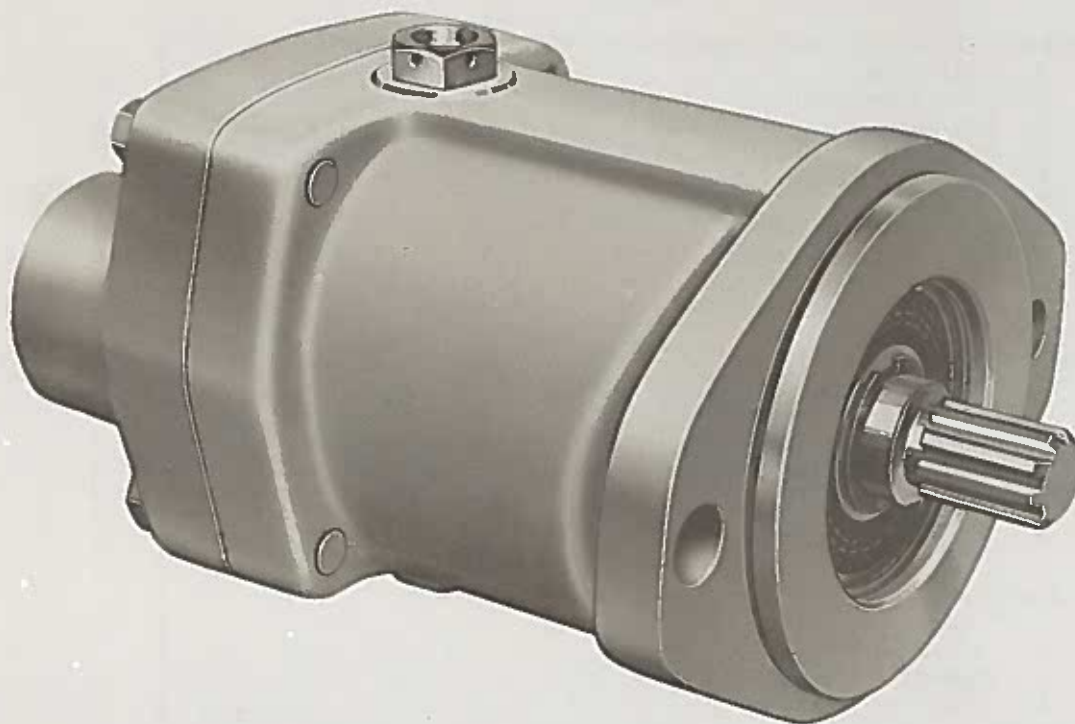
VICKERS

Overhaul Manual

**INLINE
PISTON
PUMPS**

M-PFB and M-PVB Series

12



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 12-1-85

M-2200-S

A Libbey-Owens-Ford Company

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SECTION I - INTRODUCTION

A. PURPOSE OF MANUAL

The purpose of this manual is to describe the basic operational characteristic and to provide service and overhaul information for Vickers Fixed and Variable Delivery In-Line Piston Pumps. Models included in this series are listed below in Table I. Information contained in this manual pertains to the latest designs. Earlier designs are covered only to the extent of their similarity to present equipment.

B. GENERAL INFORMATION

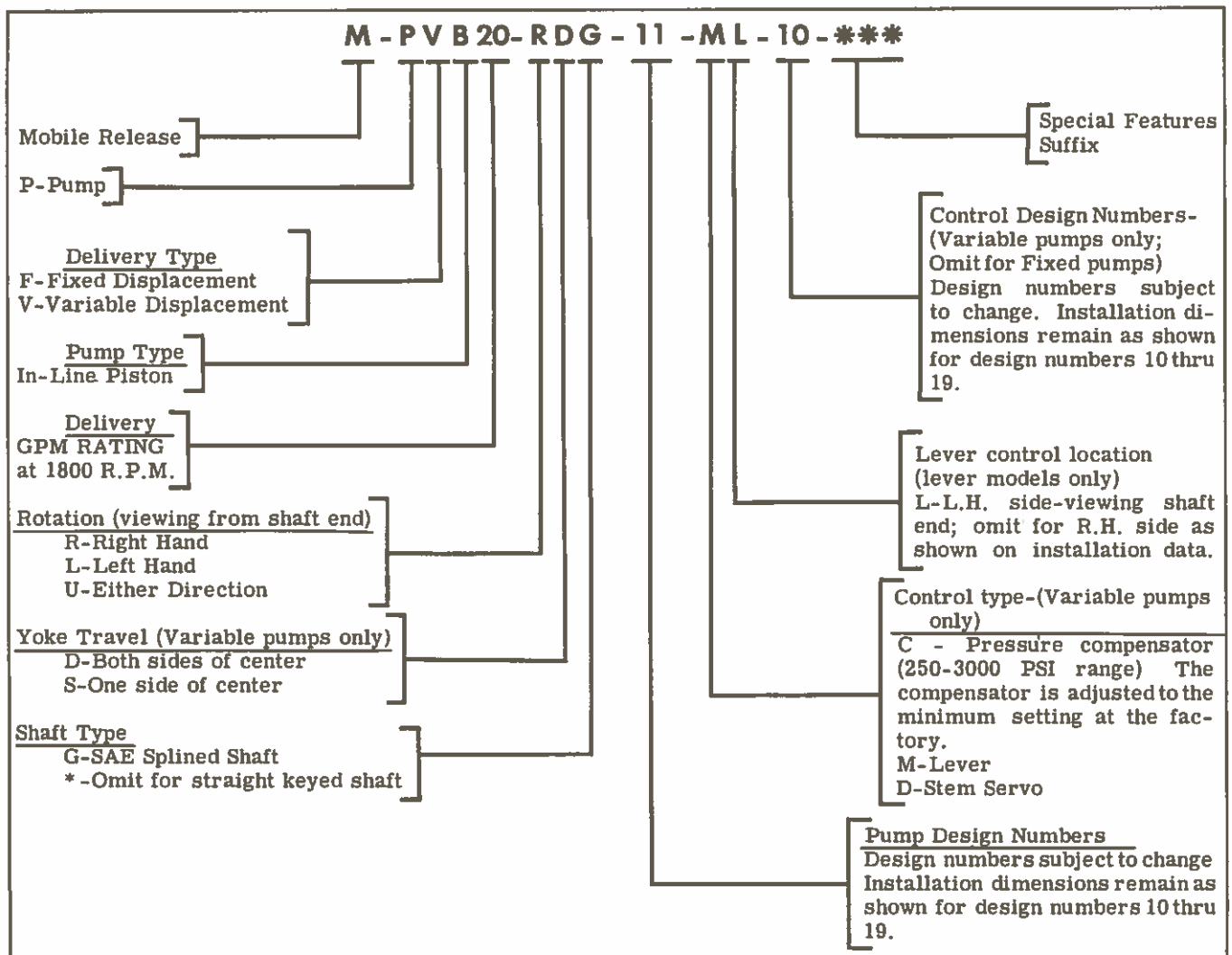
1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The installation drawings and parts catalogs listed in Table I are available from any Vickers Mobile Division Application Engineering Office or from the address shown on the cover of this manual.

2. Model Codes - There are many variations within each basic model series, which are covered by variables in the model codes indentifying these units. Service inquiries should always include the complete unit model number, which is stamped on the name plate. See Table II for a complete breakdown of the codes covering these Mobile pumps.

TABLE I

MODEL DESIGNATION	INSTALLATION DRAWING	PARTS CATALOG
M-PFB5	M-289424	M-2201-S
M-PFB10	M-289419	M-2202-S
M-PFB20	M-289426	M-2203-S
M-PVB5	M-289424	M-2211-S
M-PVB10	M-289419	M-2212-S
M-PVB20	M-289426	M-2213-S

TABLE II
MODEL CODE BREAKDOWN



SECTION II - DESCRIPTION

A. GENERAL

Vickers In-Line Pumps are of the axial piston, positive displacement type and include both fixed and variable (adjustable) displacement pumps capable of high pressure operation. Drive speeds vary with the model, type of fluid used, and circuit application.

B. ASSEMBLY AND CONSTRUCTION

The assembly of typical fixed and variable displace-

ment units together with their ASA symbols are shown in Figure 1. As illustrated the major components of the Fixed In-Line unit are the housing, drive shaft, rotating group, swash plate and valve plate. The variable displacement units incorporate a mechanism which governs the angle of the swash plate and consequently controls the stroke length of each piston as the cylinder block and drive shaft rotate. The valve plate sub-assembly also serves as the back cover of the entire unit and includes the inlet and outlet ports. A bearing in the cover and one in the housing support the drive shaft.

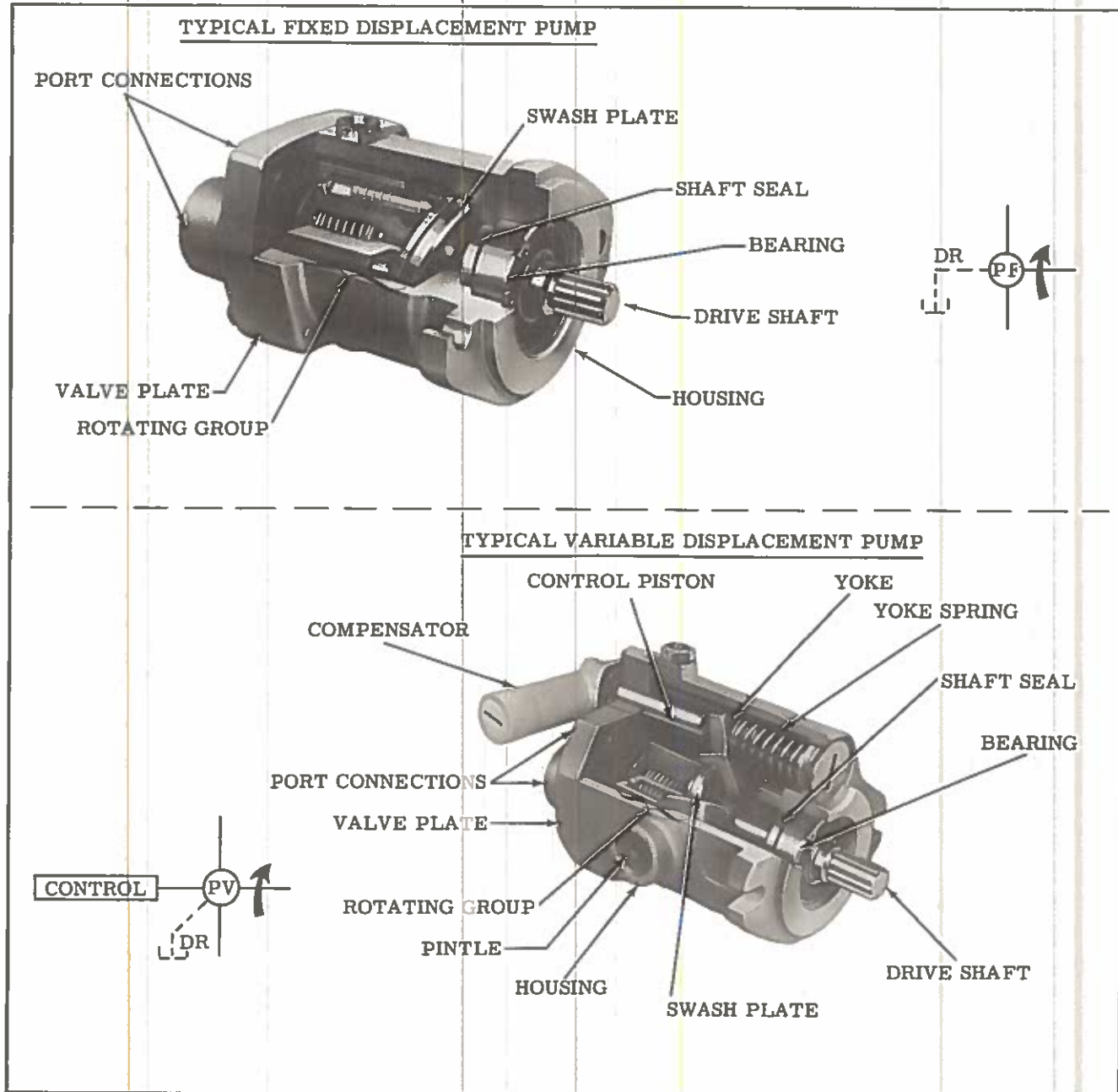


Figure 1

C. APPLICATION

The installation drawings give the nominal pump

performance characteristics and limits. For applications outside of the given limits the Mobile Engineering Department should be consulted.

SECTION III - PRINCIPLES OF OPERATION

A. GENERAL

Rotation of the drive shaft imparts a reciprocating motion to the pistons with respect to their cylinder block bores, as a result of the angularity between the axis of rotation of the drive shaft and the plane of the piston shoe bearing surface on the swash plate (See Figure 2). Each piston reaches two dead-center positions in one revolution or cycle.

As the piston revolves past the top dead-center position (when the piston is nearest the valve plate), it begins to withdraw from the cylinder block bores and thus begin its intake or suction stroke. During the intake stroke of the piston, fluid is drawn into the corresponding cylinder block bore through a porting arrangement located on the face of the valve plate and cylinder block.

As the piston reaches bottom dead-center position (when the piston is furthest from the valve plate) its withdrawing motion ceases, ending the intake stroke. This point is 180° from top dead-center. Further rotation of the cylinder block, and piston, creates a return motion of the piston towards the valve plate and thereby establishes the discharge stroke of the piston. During the discharge stroke, fluid is expelled from the cylinder block bore through the outlet port of the valve plate in a reverse manner to the intake stroke.

When the piston reaches top dead-center, axial piston motion ceases, and the discharge stroke is ended. The pumping cycle described above is made by each piston as it and the cylinder block are revolved through 360° .

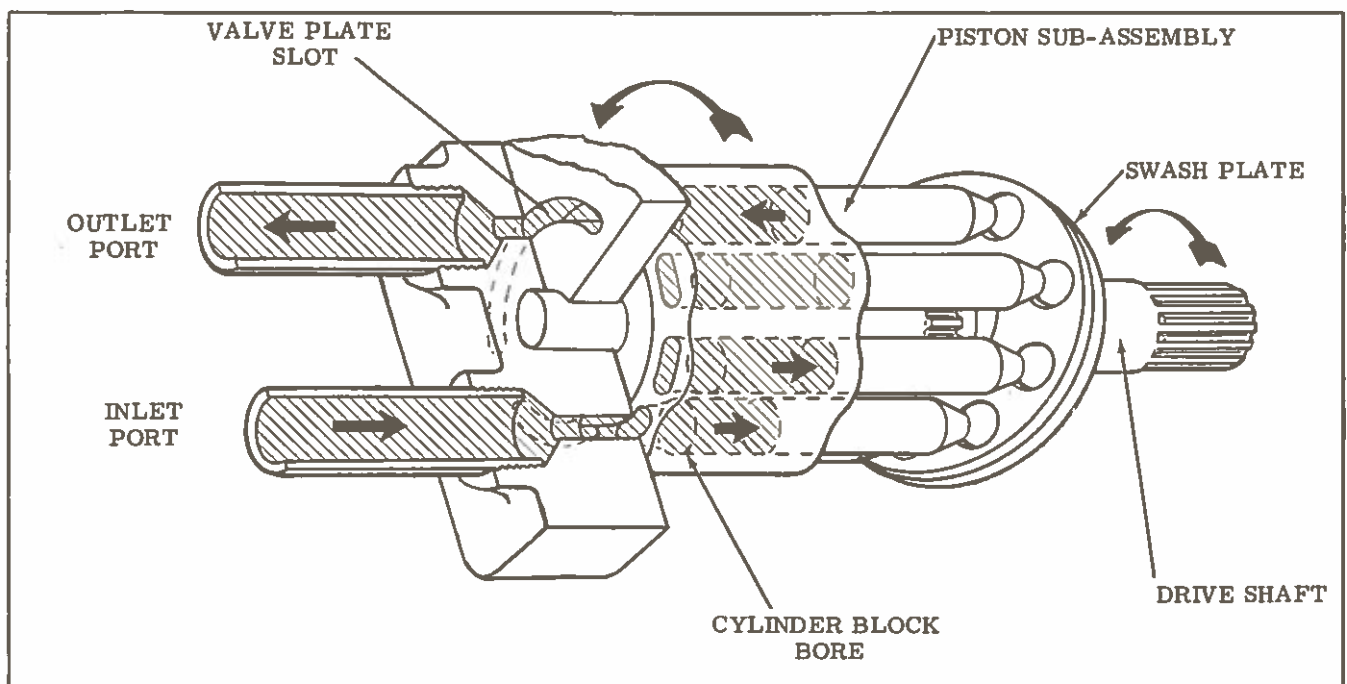


Figure 2.

B. FIXED DISPLACEMENT PUMPS

Since the swash plate angle in fixed displacement pumps is not variable, the output is determined by pump size and the speed of rotation.

C. VARIABLE DISPLACEMENT PUMPS

Variable displacement is effected by altering the angularity between the swash plate and the drive shaft axis as shown by views A, B, and C in Figure 3.

The pressure compensator is a spring-biased pressure actuated three-way valve, incorporated onto the

valve plate. The operation of the compensator is such that when the system pressure (pump outlet) reaches a pre-set value, determined by the compensator spring setting, the valve moves to regulate the control pressure acting on the actuating piston. As the force produced by the actuating piston overcomes the force of the opposing springs and other forces, the swash plate angle moves toward the minimum displacement position, View C, Figure 3. The amount of angular movement of the swash plate (ie: displacement change) is determined by system flow demand and the resulting system pressure. Equilibrium is achieved when the new displacement (ie: pump delivery) matches the system requirement.

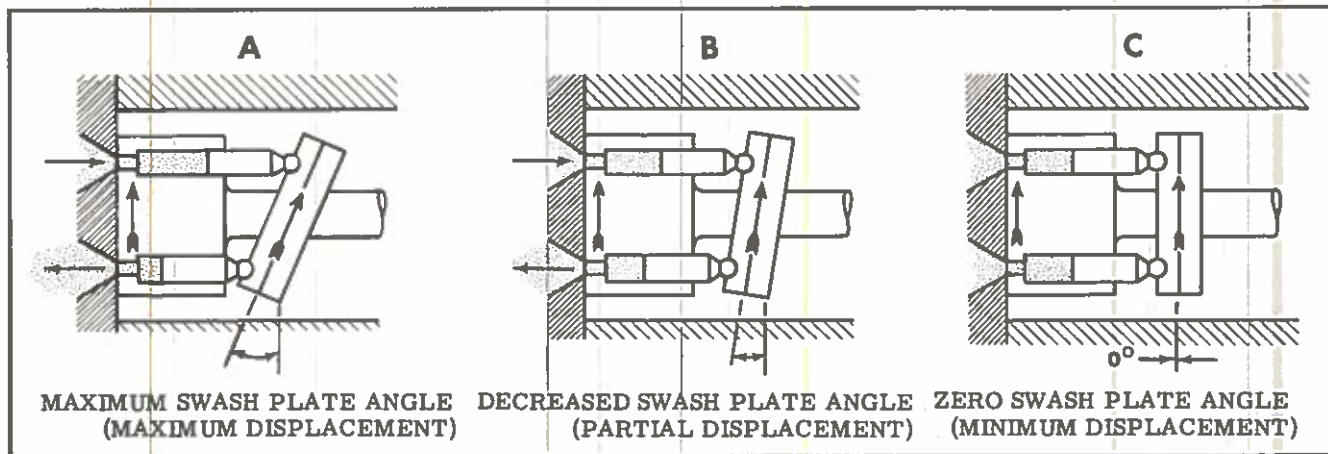


Figure 3.

SECTION IV - INSTALLATION AND OPERATING INSTRUCTIONS

A. INSTALLATION

Installation drawings shown in Table I should be consulted for installation information.

B. DRIVE CONNECTIONS

CAUTION

Vickers pump shafts are designed to be installed in flexible couplings with a slip fit or very light tap. Pounding can injure the bearings. Shaft tolerances are shown on the installation drawings. (See Table I)

1. Direct Drives - Care must be exercised when mounting the pump so that the pilot diameter fits properly into the mating section of the prime mover. (See Figure 4.) The pilot should not be forced into the mating part under any condition. Care should be exercised in tightening all flange mounting screws to prevent misalignment of shaft connections.

Shaft alignment is critical. Displacement or angularity can cause shaft breakage or bearing problems quickly, due to overloading.

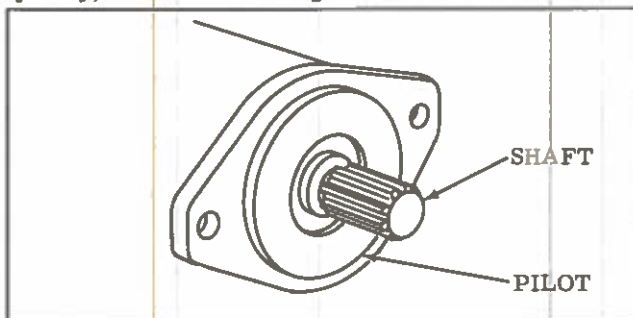


Figure 4.

2. Indirect Drives - For indirect drive applications the magnitude of side force, shown on the installation drawings, (Table I) relative to the mounting face must not exceed the indicated value at rated speed and pressure. For combined thrusts and side loads or other speeds and pressures, consult your local Vickers Application Engineer.

C. MOUNTING

Mounting position is unrestricted, provided that proper component-to-reservoir relationship is maintained. An unrestricted housing drain line must be connected from the uppermost drain port directly to the reservoir in such a manner that the housing remains filled with oil at all times. The drain line should be at least full size, or oversize depending upon its length. Proper drain line size will prevent a build-up of housing pressure and also allows oil to flow freely into the pump housing under certain severe operating conditions. No other drain line should tie in to the housing drain line.

The housing drain line connection to the reservoir must be submerged in oil at all times. If the drain line is above the oil level, damage to the unit may result due to air being drawn into the pump.

If pump mounting will not permit the housing drain line connection to be at the highest point, the drain line should be rigid, such as metal pipe or tubing. Loop the drain line above the highest point of the pump to prevent the oil from siphoning or draining from the housing during shut-down periods as shown in Figure 5.

Fill the pump housing with oil through the uppermost drain port. The housing must be kept full to provide internal lubrication.

NOTE

Pipe threaded ports are not available because of valve plate distortion. Plumbing should be attached in a manner that will not cause valve plate distortion.

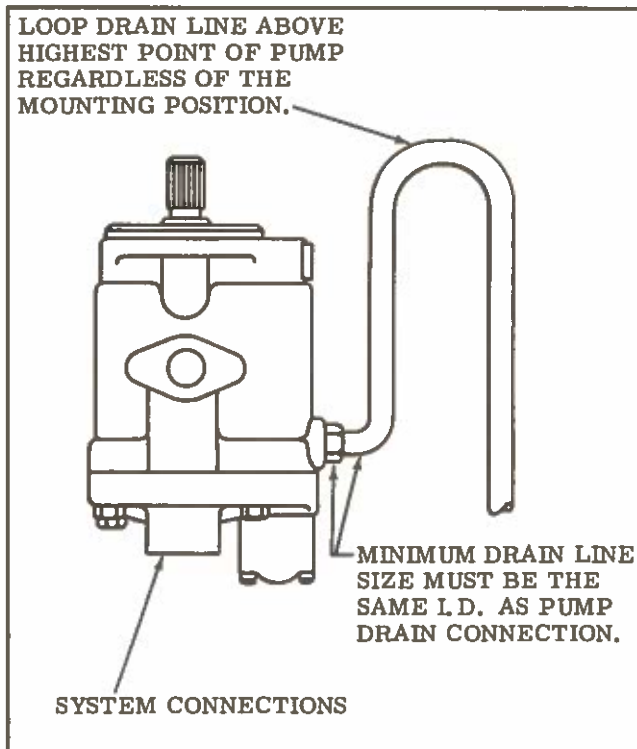


Figure 5.

D. SHAFT ROTATION

The rotation of Vickers pumps are always as viewed from the shaft end of the pump as shown in Table II.

E. HYDRAULIC TUBING

1. The number of bends in tubing must be kept to a minimum to prevent excessive turbulence and friction of oil flow (contributing to system inefficiency).

2. Tubing must not be bent too sharply. The recommended minimum radius for bends is three times the inside diameter of the tube.

3. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

4. All tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are wire brushing and pickling.

F. INLET LINE

The inlet line must be full size or oversize and not restricted at any point between pump inlet connection and the reservoir. A line size allowing less than 5

ft. per sec. fluid velocity should be your goal. The use of restrictive inlet tubing, undersize filter or an improper grade of fluid may result in inlet vacuum conditions exceeding the recommended value and cause cavitation in the pump.

These pumps should not be operated with a vacuum greater than 5" at the inlet or a housing pressure greater than 5 psi, unless specifically approved by Vickers Engineering.

NOTE

No application factor is more important to the success of a pump than the inlet line. Considering the large flow in such lines and the very little pressure available to move the fluid, line size is obviously important.

Cavitation is the rapid formation and collapse of vapor pockets within the fluid and can cause excessive damage to the unit. Check the appropriate installation drawing for maximum pump speed for your inlet pressure.

G. FILTRATION

Provide a check valve by-pass around the filters to provide a fluid path in the event that clogging of the filter occurs. We recommend the use of 25 micron pressure or return line filter.

All intake type filters should be equipped with magnets. In addition, all new and make-up fluid to the reservoir should be filtered through a 25 micron rated filter. Vickers Engineering Department should be consulted when any unusual fluid or viscosity conditions are encountered.

H. HYDRAULIC FLUID RECOMMENDATIONS

1. **Oil Type** - Oils used in hydraulic systems perform the dual function of lubrication and transmission of power. Oil must be selected with care and with the assistance of a reputable supplier.

Crankcase oils meeting or exceeding the "Five Engine Test Sequence" for evaluating oils for API (American Petroleum Institute) service MS (Maximum Severity) best serve the needs of Mobile hydraulic systems. These engine sequence tests are adopted by the Society of Automotive Engineers, American Society for Testing Materials, and Automotive engine builders. The MS classification is the key to selection of oils containing the type of compounding that will extend the operating life of the hydraulic system. Oils meeting Diesel engine requirements, DG through DS classifications, may or may not have the type of compounding desired for high performance hydraulic systems.

Table III summarizes the oil types (viscosity and service classification) that are recommended for use with Vickers equipment. This selection is most important and should be made with considerable care.

TABLE III

Hydraulic System Operating Range	SAE Viscosity	API Service Classification
(Min. to Max.)		
0°F. to 180°F.	10W	MS
15°F. to 210°F.	20-20W	MS
32°F. to 230°F.	30W	MS
0°F. to 210°F.	10W-30	MS

For moderate service applications use oil in accordance with specifications shown above. For high speed-high pressure applications or speeds below 100 RPM at high pressure use one viscosity heavier oil.

Good oils are the most economical. Specifications can be set up which will indicate, to a limited degree, the characteristics essential in a good hydraulic oil. These are listed herein and should be checked with the oil manufacturer prior to the use of his product.

2. Operating Temperatures - The temperature ranges for each grade of oil are satisfactory if suitable speed control procedures are followed for low temperature start-up conditions and if sustained operation is avoided at the upper temperature limits. Operation in excess of these temperatures results in increased wear of the system components and causes rapid deterioration of the oil. For optimum operation, a maximum oil viscosity of 4000 SSU at the low temperature start-up condition and a minimum oil viscosity of 60 SSU for the sustained high temperature operating condition are recommended.

3. Viscosity - Viscosity is the measure of fluidity. The oil must have sufficient body to provide adequate lubrication and sealing effect between working parts of pumps, valving, cylinders, etc. but not enough to cause pump intake cavitation or sluggish valve action. Viscosity recommendations must at best be a compromise which takes into consideration the working temperature range, the type of hydraulic equipment used, and the class of service. Refer to the table of oil viscosity recommendations.

4. Viscosity Index - The viscosity index is a measure of the rate at which temperature changes cause a change in oil viscosity. It is very desirable that the oil viscosity remain as nearly constant as possible under the wide range of temperature conditions encountered in operating mobile and construction machinery. The viscosity index (V.I.) of hydraulic oil should be not less than 90 for this type of service.

5. Additives - Research has developed a number of additive agents which materially improve various characteristics of oils for hydraulic systems. They may be selected for compounding with a view toward reducing wear, increasing chemical stability, inhibiting corrosion, depressing pour point and improving the anti-foam characteristics. Proper use of additive agents requires specialized knowledge, and they should be incorporated by the oil manufacturer only, as serious trouble may otherwise result.

Most companies have several brands of crankcase oils of somewhat varying formulation that will meet the API service classification of MS. The more desirable of these oils for hydraulic service will contain higher

amounts of the type of compounding that avoids scuffing and wear of cam lobes and valve lifters. These oils will also be formulated to be stable under oxidative conditions and when in contact with small amounts of moisture. There should also be reasonable protection against rust to any ferrous materials submerged in the oil or covered by the oil film.

6. Cleanliness - Thorough precautions should be taken to filter the oil in the entire hydraulic system prior to its initial use to remove paint, metal chips, welding slag, lint, etc. If this is not done, damage to the hydraulic system will probably result. In addition, continuing filtration is required to remove sludge and products of wear and corrosion, throughout the life of the system.

Precautions should be taken in the design of hydraulic circuits to assure that a means is provided to keep the oil clean. This can best be accomplished by the use of a 25 micron full-flow filter or a 10 micron by-pass filter plus a micronic filter type air breather or sealed reservoir.

7. Miscellaneous - The performance of hydraulic valves and cylinders is less affected by the lubricating quality of the oil, and, therefore, selection of the oil is less critical than for pumps and motors. It is always good practice, however, to use the best quality oil available for all components.

I. OVERLOAD PROTECTION

Normally, a pump equipped with a pressure compensator requires no external relief valve. In some applications, a relief valve may be desirable for maximum system protection. The setting of the relief valve should be at least 250 psi above the maximum pressure setting of the compensator.

J. STARTING AND PRIMING

NOTE

In most cases "break in" is not a problem but when it is, it can be compared with new engines, gear boxes and other products. A by-product of "break in" is self generated dirt. Generous filters and good filter maintenance are required to be sure a unit is "broken in" and not "broken up".

1. PRECAUTIONS:

(a) Make sure the reservoir air cleaner is clean and of ample size to handle the breathing requirements.

(b) Make certain the hydraulic system is clean and free of dirt, metal chips, paint, welding slag and foreign material. System filtration should be 25 microns or finer.

(c) Make sure all inlet and return line fittings are tight so that air is not drawn into the system.

(d) Make sure the system is full of oil. Most of the MS crankcase oils will serve the needs of in-line pump applications (refer to fluid recommendations in Section IV, H of this manual).

(e) Make sure rotation direction and coupling alignment are correct.

2. STARTING PROCEDURE:

(a) Variable pumps must be started with the yoke position exceeding 40% of full stroke. Back off system relief valve so that the pump will start under no-load conditions. If the system relief valve is not adjustable, start the engine and let it run at low speed.

CAUTION

BE ABSOLUTELY SURE THE HOUSING IS FULL OF OIL BEFORE STARTING. FILL THE HOUSING WITH SYSTEM FLUID THROUGH THE UPPERMOST DRAIN PORT.

(b) Be sure the pump primes within the first minute of operation. If it does not prime, recheck the reservoir to make sure it is full of oil.

(c) Bleed the outlet line until a clear stream of oil results with no air bubbles present. This is

best accomplished by loosening an outlet fitting next to the pump. Slowly extend and retract all hydraulic cylinders in the circuit and again bleed the outlet line. It may be necessary to bleed the circuit several times in order to remove all the air trapped in the circuit.

If the air is not expelled from the circuit after several attempts, check the inlet lines to make sure all the fittings are tight. When a hose is used for the inlet line, it is not uncommon for it to leak where it is attached to the fitting, and allow air to be drawn into the system.

(d) Allow the unit to run at reduced speed for as long as possible, while checking the system for leaks and bleeding air out of the lines. Do not remove the compensator adjustment plug while the pump is in operation.

SECTION V - SERVICE, INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

Special tools required for these units are a shaft seal driver and a bearing puller of suitable size. The seal driver can be made from round stock machined as shown in figure 6.

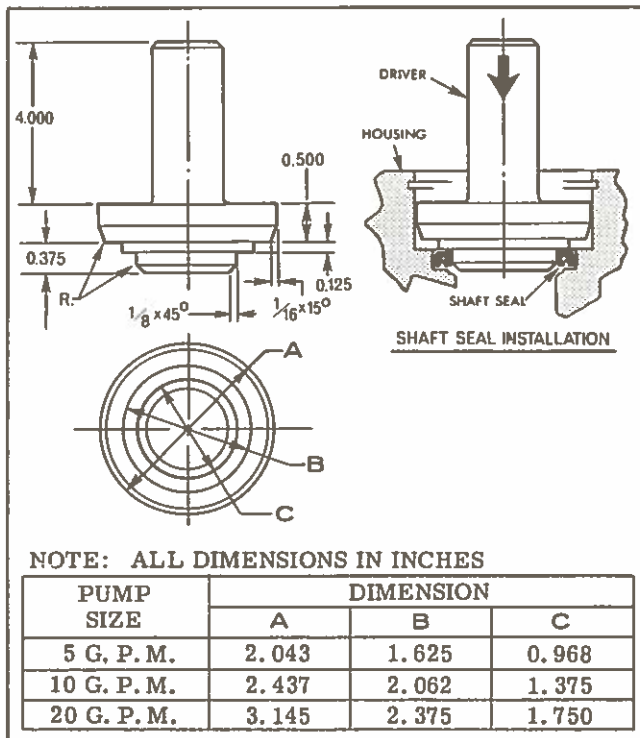


Figure 6

B. INSPECTION AND SERVICE

Periodic inspection of the fluid condition and tube or pipe connections can prevent both time consuming breakdowns and unnecessary repairs. Since pumps depend on the fluid in the system for internal lubrication, clean fluid is important to service life. If the fluid becomes contaminated, thoroughly drain the system and clean the reservoir before new fluid is added. Insure that all hydraulic connections are kept tight. In a pressure line, a loose connection permits the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive

damage to the component may result. In the suction or return lines a loose connection will permit air to be drawn into the system, resulting in noisy or erratic operation, or pump breakdown, also "spongy" operation.

Check and replace filter elements, periodically. A clogged filter element results in a higher pressure drop, forcing particles through the filter which would ordinarily be trapped, or causing the by-pass to open resulting in a partial or complete loss of filtration.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a micron filter. If such a filter is not available, a funnel with a fine wire screen (200 mesh or better) can be used.

It is important that oil be clean and free of all substance which will cause improper operation and excessive wear of any unit in the system.

D. LUBRICATION

Internal lubrication is provided by system oil flow. Except main bearing which must be packed 1/3 full of high temperature grease when unit is rebuilt.

E. REPLACEMENT PARTS

Only genuine parts manufactured or sold by Vickers Incorporated should be used as replacement parts for these pumps. They are shown in the parts catalogs listed in Table I. Copies are available on request.

F. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

G. TROUBLE SHOOTING

The cause of improper functioning in a hydraulic system is best diagnosed with the use of proper and adequate testing equipment and a thorough understanding of the complete hydraulic system.

A hydraulic pump exhibiting an excessive increase in heat or noise is a potential failure. When either of these conditions are noticed, immediately shut down the machine, locate the trouble and correct it.

Table IV lists some of the common difficulties found in hydraulic components and systems, their probable cause and remedies.

TABLE IV - TROUBLE, CAUSE AND REMEDY CHART

TROUBLE	PROBABLE CAUSE	REMEDY
Pump not delivering fluid.	Reservoir fluid level low.	Add fluid and check level on both sides of reservoir baffle to insure pump intake line is submerged.
	Inlet strainer plugged.	Clean strainer after new fluid is added.
	Air leak in inlet line prevents priming and causes irregular control circuit action.	Pour fluid on intake joints while listening for change in sound of operation. Tighten as required.
	Coupling or shaft sheared or disengaged.	Disassemble pump and check shaft, and rotating group for damage. Replace necessary parts.
	Pump driven in wrong direction of shaft rotation.	Check installation. Reverse the drive or convert pump as discussed in the overhaul section.
System not developing pressure.	Contamination in actuating control.	Clean control.
	Pump not delivering fluid for any of the above reasons.	Check circulation by watching fluid in reservoir.
	Relief valve setting not high enough.	Block machine travel. Test with pressure gauge.
	Relief valve sticking open.	Remove contamination in relief valve.
	Leak in hydraulic control system (cylinders or valves).	Test independently by progressively blocking off the circuit.
	Free Re-circulation of fluid to reservoir.	Insure that directional valve is not in open center (neutral) position or that fluid is not discharging to tank through an open line or improperly adjusted valve.
Pump making excessive noise	Partly clogged inlet line, inlet strainer or restricted inlet pipe.	Service the inlet strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	Air leak at pump intake pipe joints.	Tighten as required. Pour fluid on joints while listening for change in sound of operation.
	Air bubbles in fluid.	Check to be certain return lines are below fluid level and well separated from intake line.
	Reservoir air vent plugged.	Must be open through breather opening or air filter.
	Pump running too fast.	Conform with recommended maximum speeds shown in installation drawings.
	Filter too small on inlet.	Refer to appropriate installation drawings for proper size filter.
	Coupling misalignment.	Check for damaged shaft bearing or other parts. If necessary, replace and realign the coupled shaft.

SECTION VI - OVERHAUL

A. GENERAL

Before breaking a circuit connection, be certain that the power is off and the system pressure has been released. Lower all vertical cylinders, discharge all accumulators and block any load whose movement could cause a pressure generation.

During overhaul, plug all units and cap all lines

to prevent entry of dirt into the system. During disassembly, pay special attention to identification of parts, especially those of the rotating group, for correct reassembly. Figure 7 is a disassembled view of a typical fixed displacement pump, while Figure 8 is a disassembled view of a typical variable displacement pump. Figure 1 may be referred to for the correct relationship of the parts.

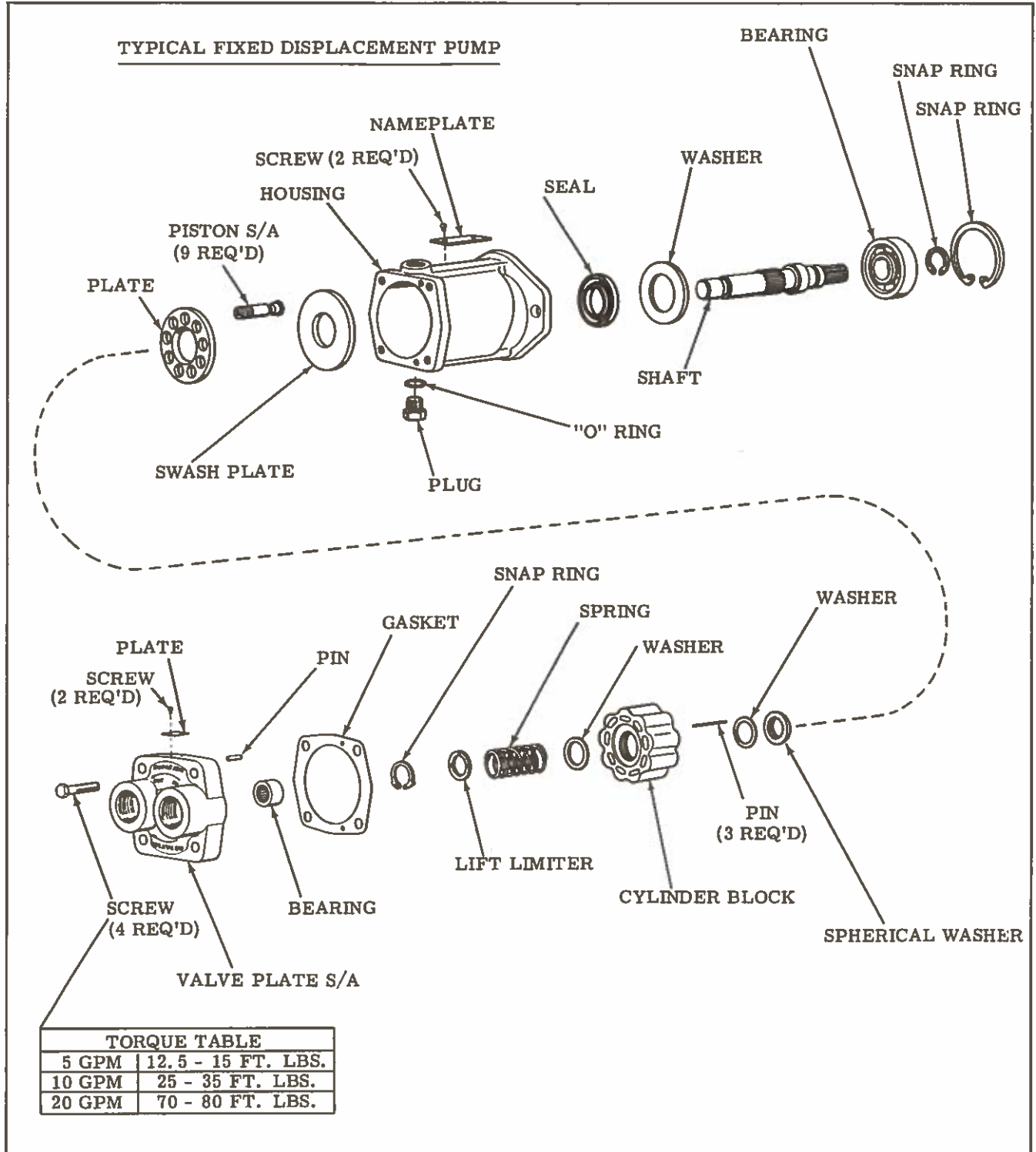
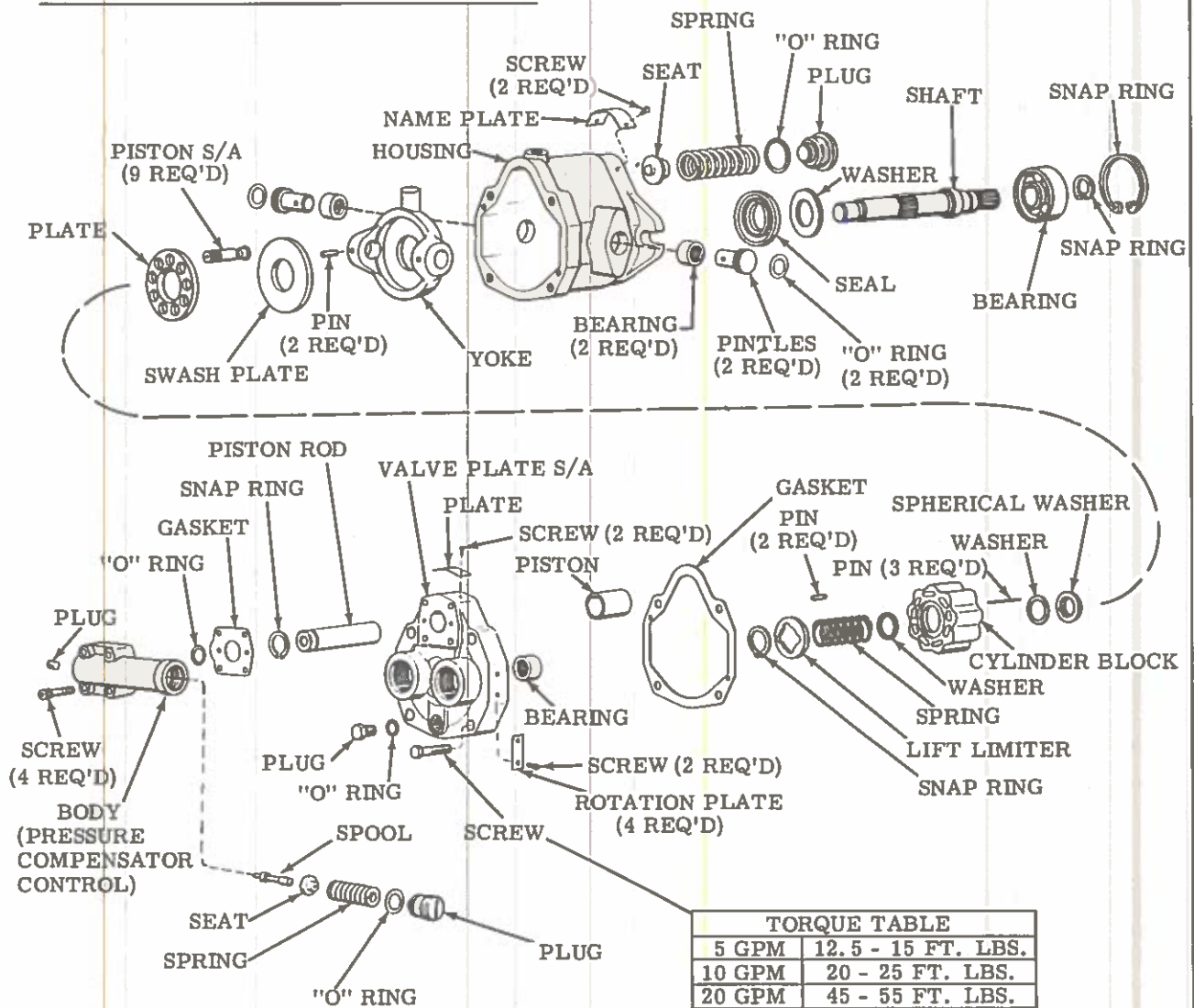
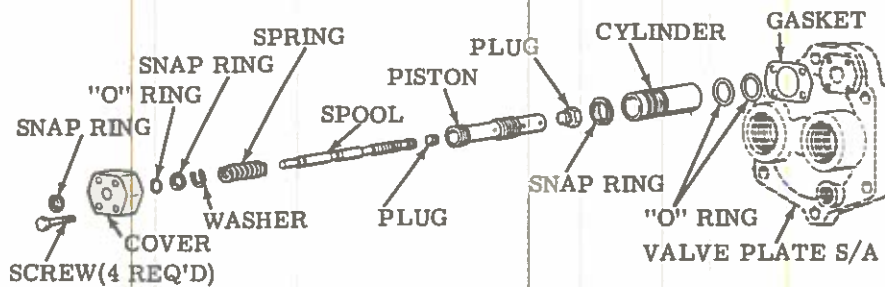


Figure 7

TYPICAL VARIABLE DISPLACEMENT PUMP



STEM SERVO CONTROL



MANUAL LEVER CONTROL

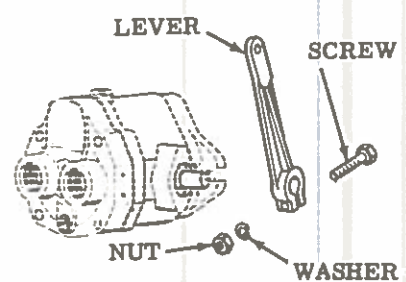


Figure 8

B. DISASSEMBLY

All models are disassembled in the same general sequence as shown in the exploded views of Figure 7 and 8.

1. Valve Plate - On pressure compensated models, remove the compensator body first to permit removal of the valve plate retaining bolts. Remove the valve plate from the unit. A commercially available bearing puller should be used for removal of the valve plate bearing if it is to be replaced.

2. Rotating Group Removal - Turn the rotating group slightly to free it from the swash plate. Tilt the housing and remove the rotating group. Care should be taken to prevent the separation of the cylinder block from the rotating group during removal from the housing.

3. Rotating Group Disassembly - Lift the piston and shoe sub-assemblies from the cylinder block. Keep the pistons from striking hard objects during handling of the rotating group sub-assembly.

WARNING

If the spring and washer are to be removed from the cylinder block, follow the procedure outlined in Figure 9 to prevent bodily injury from the sudden release of the cylinder block spring.

4. Swash Plate Removal - The swash plate outside diameter is smaller than the inside diameter of the recess in the yoke. A properly seated swash plate can be freely rotated with the fingertips. Removal, however might be slightly difficult due to oil suction under the swash plate. Rotate the swash plate and pull out evenly from the yoke.

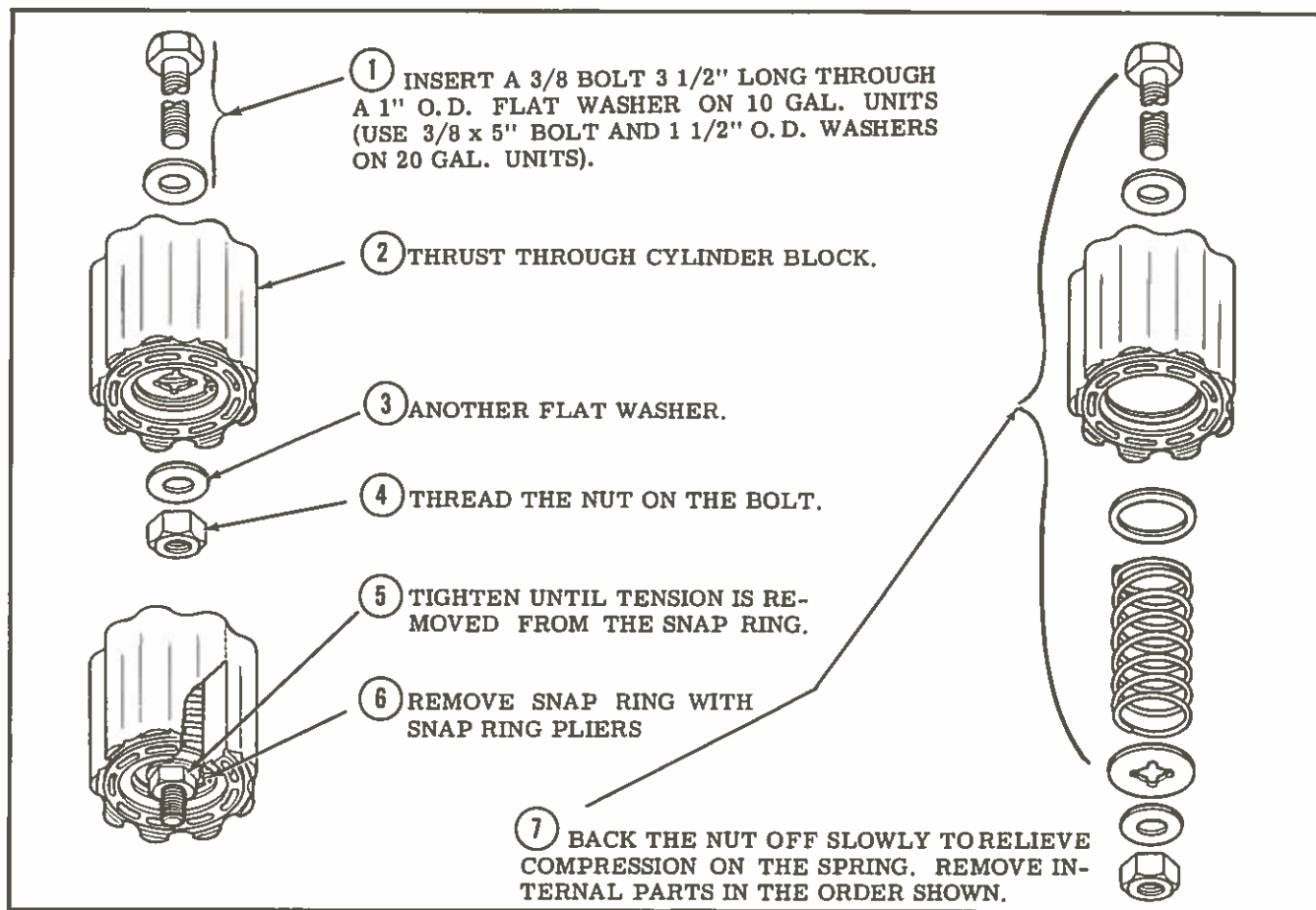


Figure 9

5. Drive Shaft Removal - Remove the retaining snap ring with snap ring pliers. Tap the end of the drive shaft with a soft tip hammer to free the shaft and bearing from the housing. It may be necessary to use a commercial bearing puller to remove the main bearing from the housing. Removal of these bearings often destroys them and replacement parts should be

available prior to removal.

6. Yoke Removal - Figures 10 and 11 illustrate the procedure for removal of the yoke from a variable displacement unit. Yokes of the smaller units are similar in design to the larger units. Only the methods of retaining are different.

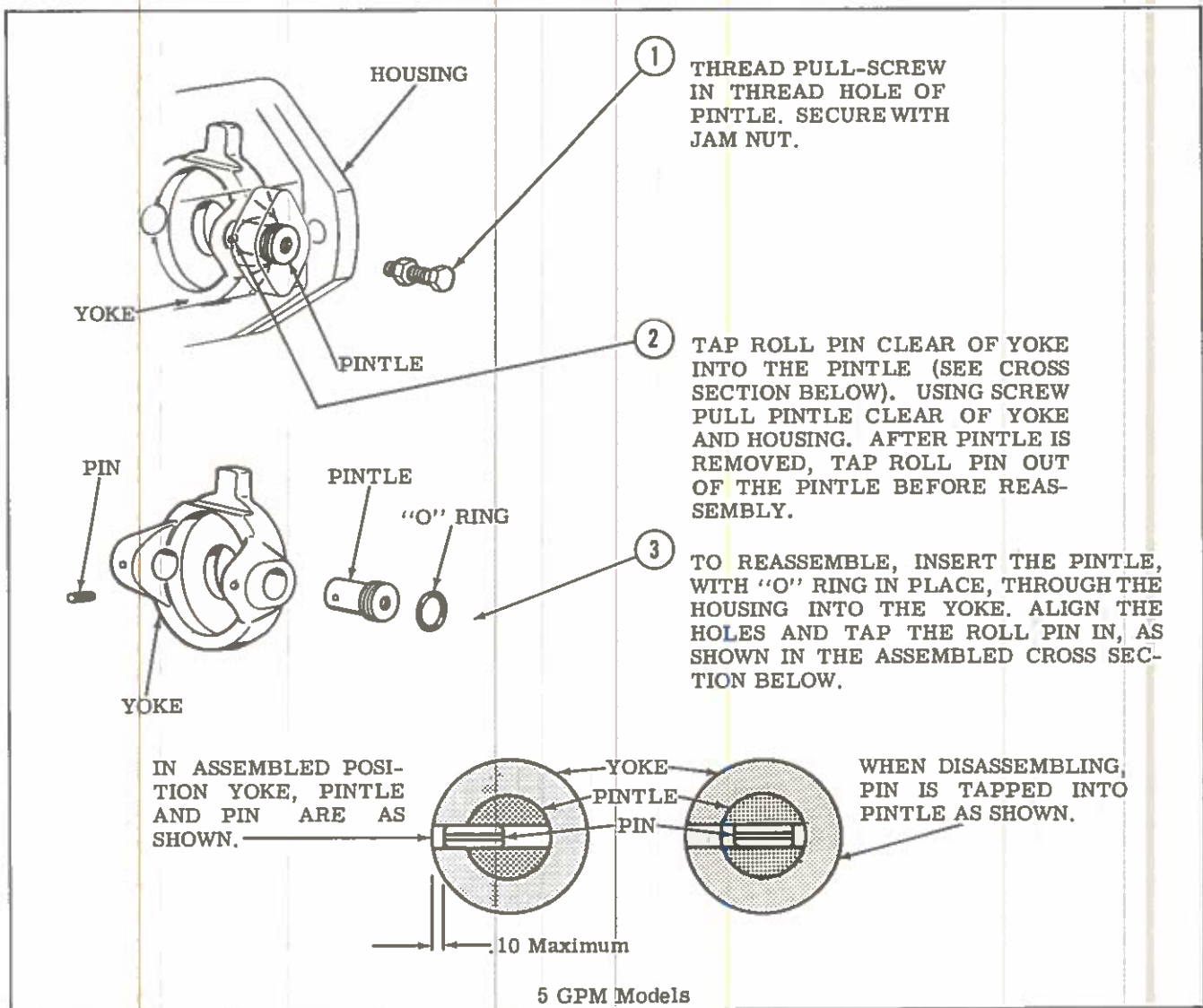


Figure 10

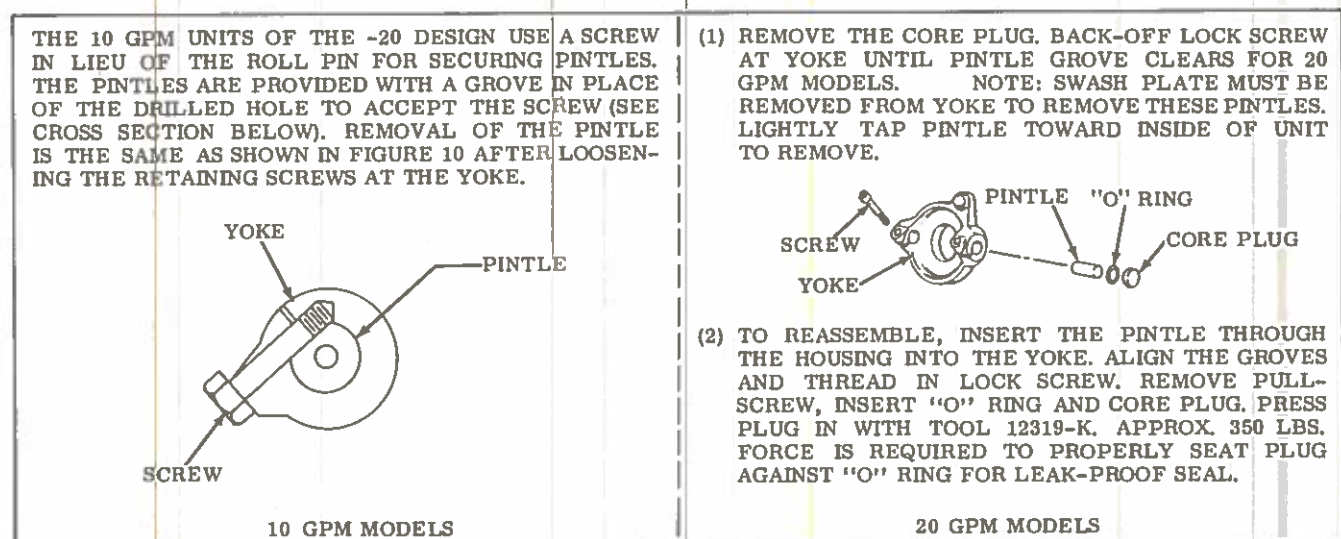


Figure 11

C. INSPECTION AND REPAIR

Clean all parts thoroughly with a mineral oil cleaning solvent prior to inspection and after any lapping or machining operation.

1. Valve Plate - Inspect the flat surface which mates with the cylinder block for wear or scoring. Minor defects can be removed by lightly stoning the surface, however any lapping should not exceed 0.0004 inches. The surface is hardened and excessive lapping will remove this hardened surface. If the wear or damage is extensive replace the valve plate.

2. Rotating Group - Inspect the bores and valve plate mating surface of the cylinder block for wear and scoring. Minor defects on valve plate mating face can be removed by lightly stoning the surface. If the defects cannot be removed by this method the cylinder block should be replaced.

When conditions indicate that one or more piston and shoe sub-assembly should be replaced, all piston and shoe sub-assemblies in the unit should be checked as in Figure 12 to insure that all piston shoes ride properly on the swash plate. Variations greater than .001 of an inch from one shoe to another result in excessive internal leakage and shoe wear. At overhaul the replacement of all 9 piston and shoe sub-assemblies in the unit as well as the cylinder block, is recommended for maximum overhaul life.

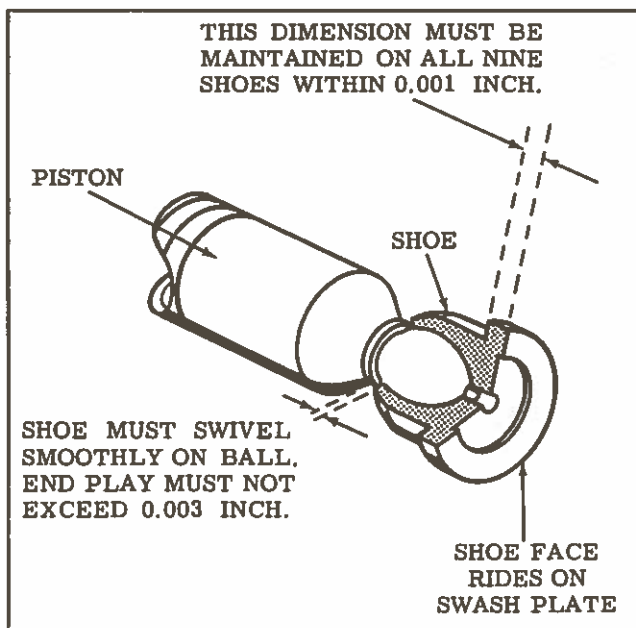


Figure 12

If necessary, hand lap the shoes using a 400 A or 500 A emery paper (Tuff-Bak Durite Silicon Carbide) backed by a lapping plate. Good results may be obtained if the paper is dipped in kerosene and kept wet

during polishing.

3. Swash Plate - Inspect the swash plate for wear and scoring. If the defects are minor, stone the swash plate but do not remove more than 0.0004 of an inch. If wear or damage is extensive replace the swash plate.

4. Bearings and Drive Shaft - Inspect all bearings for roughness or excessive play and replace if necessary. Inspect the shaft seal area of the shaft for scoring or wear. Replace the drive shaft if bent or wear is excessive.

D. ASSEMBLY

Assembly is basically the reverse of disassembly. Install new gaskets, seals, and "O" rings when assembling the unit. A light film of clean hydraulic fluid will ease assembly and provide initial lubrication.

1. Yoke - Install the yoke in the housing as illustrated in Figure 10 or 11.

2. Drive Shaft and Bearing - Install a new shaft seal in the housing. Place the washer over the shaft seal. Assure that bearing is 1/3 to 1/2 filled with a good grade of high temperature ball bearing grease, then install the drive shaft in the housing. Secure the drive shaft bearing with the retaining ring.

3. Swash Plate - Install the swash plate chamfered edge toward shaft seal. It is important that the swash plate be properly seated in the yoke, and can be freely rotated with the fingers:

4. Rotating Group Assembly - If the spring and washers were removed from the cylinder block, assemble them as shown in Figure 9.

Place the cylinder block face down on a smooth clean surface for ease of assembly. Insert the three pins in the cylinder block. Grease the back-up and spherical washers and place them on the pins. Put the nine piston and shoe sub-assemblies in the shoe plate. Carefully holding the shoe plate so that the pistons do not strike each other, align the pistons with the bores and maneuver them into place. The pistons must move freely in a lubricated block bore.

5. Rotating Group Insertion - Holding the cylinder block and shoe plate to keep the pins, washers and spherical washer intact, install the rotating group onto the drive shaft. Slight rotation during assembly will help align the spherical washer and cylinder block splines with those of the drive shaft.

6. Valve Plate - Replace the valve plate to body gasket if required and then install the valve plate with the retaining bolts. Install the compensator body on units containing the compensator feature.

SECTION VII - TESTING

Vickers Mobile Division application engineering personnel should be consulted for test stand circuit requirements and construction. If test equipment is

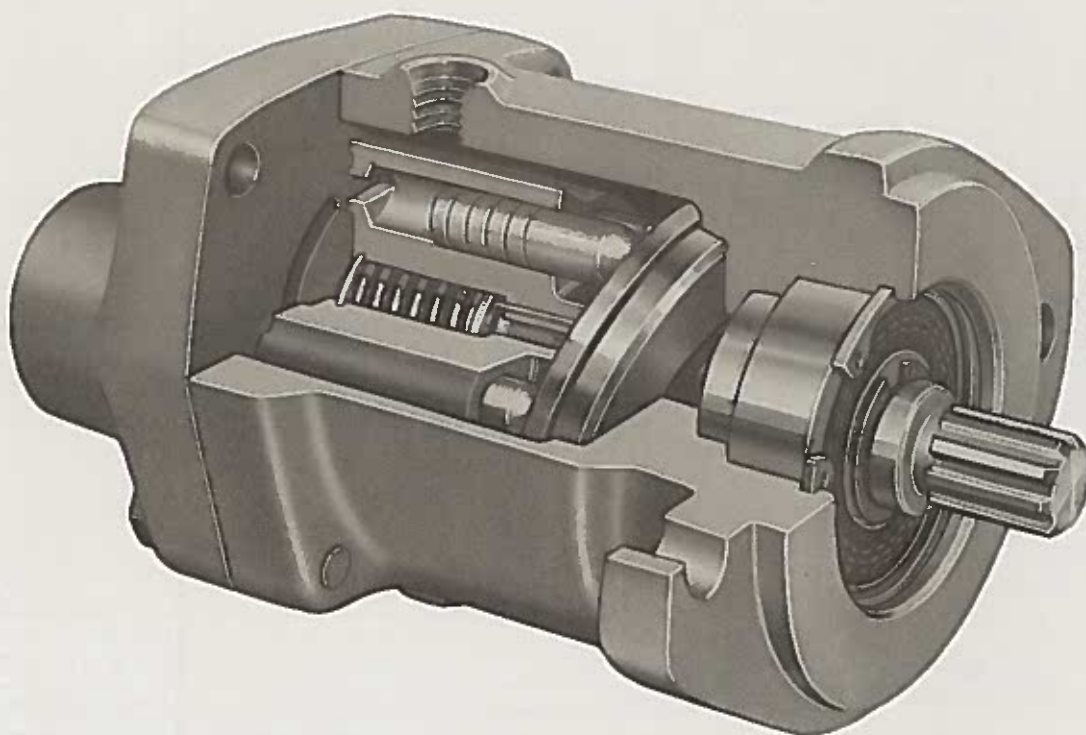
available, the pump should be tested at recommended speeds and pressures shown on the installation drawing (See Table 1).

Service Parts Information

Fixed
Inline
Piston
Pumps

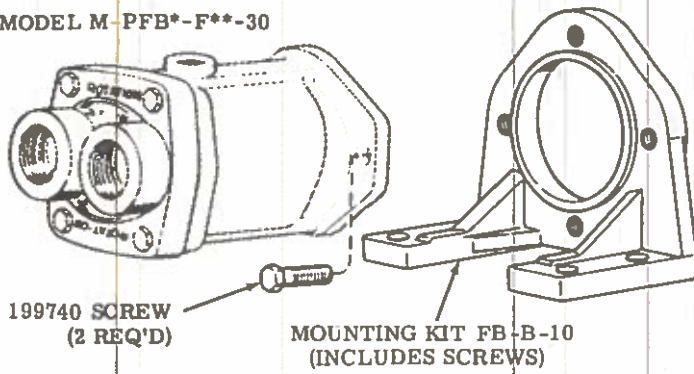
M-PFB10-30/31
M-PFB15-30

19

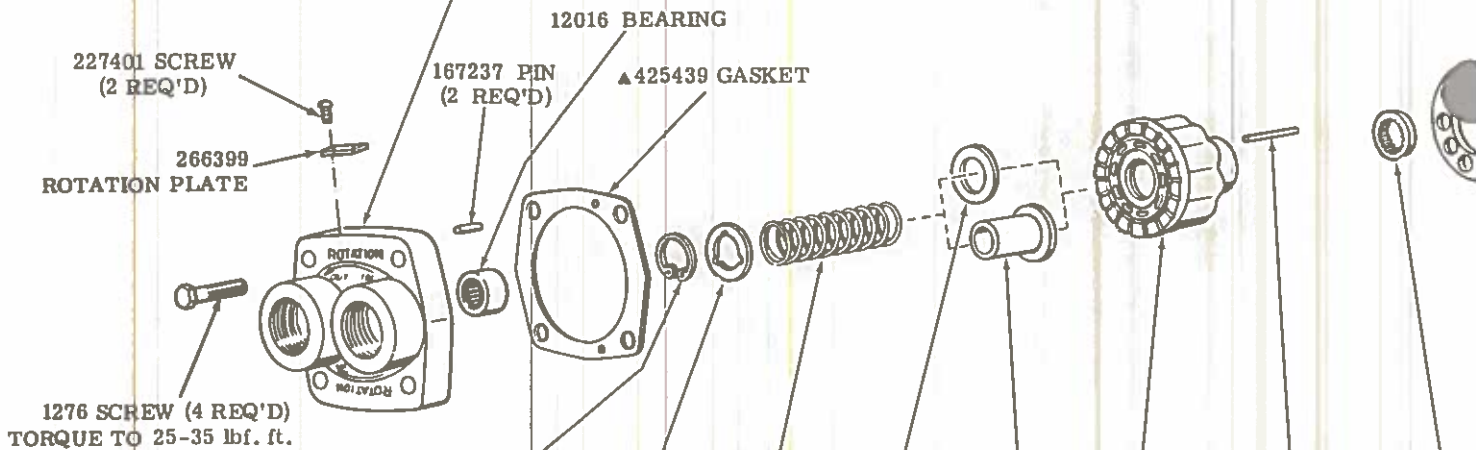


FOOT MOUNTING BRACKET

MODEL M-PFB*-F**-30

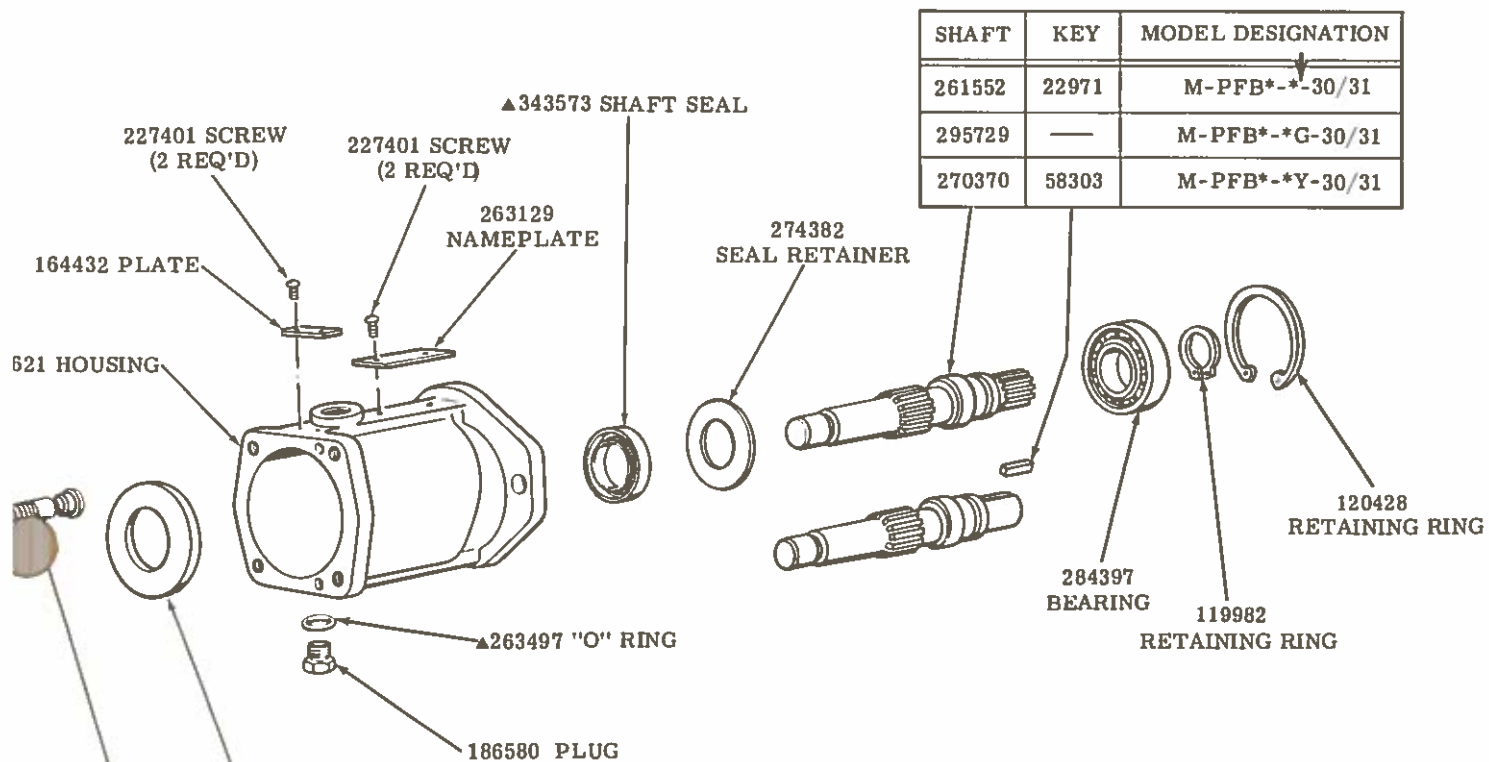


MODEL	VALVE PLATE SUB-ASSY. INCLUDES 12016 BEARING	VALVE PLATE
M-PFB10-R*-30/31	942048	—
M-PFB10-L*-30/31	942049	—
M-PFB15-R*-30	—	318338
M-PFB-10-U-31	942050	—



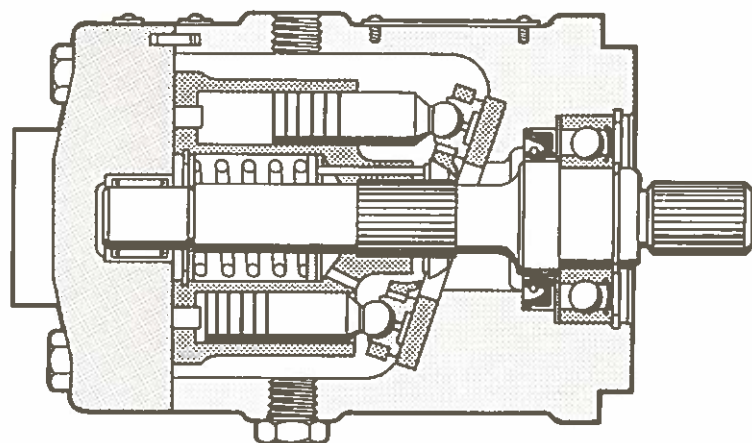
MODEL DESIGNATION	RETAINING RING	LIFT LIMITER	SPRING	THRUST WASHER	SPRING GUIDE	CYLINDER BLOCK	PIN (3 REQ'D)	SPHERIC WASHE
THESE PARTS ARE SERVICED IN ROTATING GROUP KI								
M-PFB**-30/31	93509	245223	247294	241954	—	321703	248811	423324
M-PFB15**-30				—	306868	260860		

INCLUDE COMPLETE MODEL NUMBER ON ALL PARTS ORDERS



HOE ATE	PISTON KIT (9 PISTONS)	SWASH PLATE	ROTATING GROUP KIT
5961	942047	239077	938272
	941887		923945

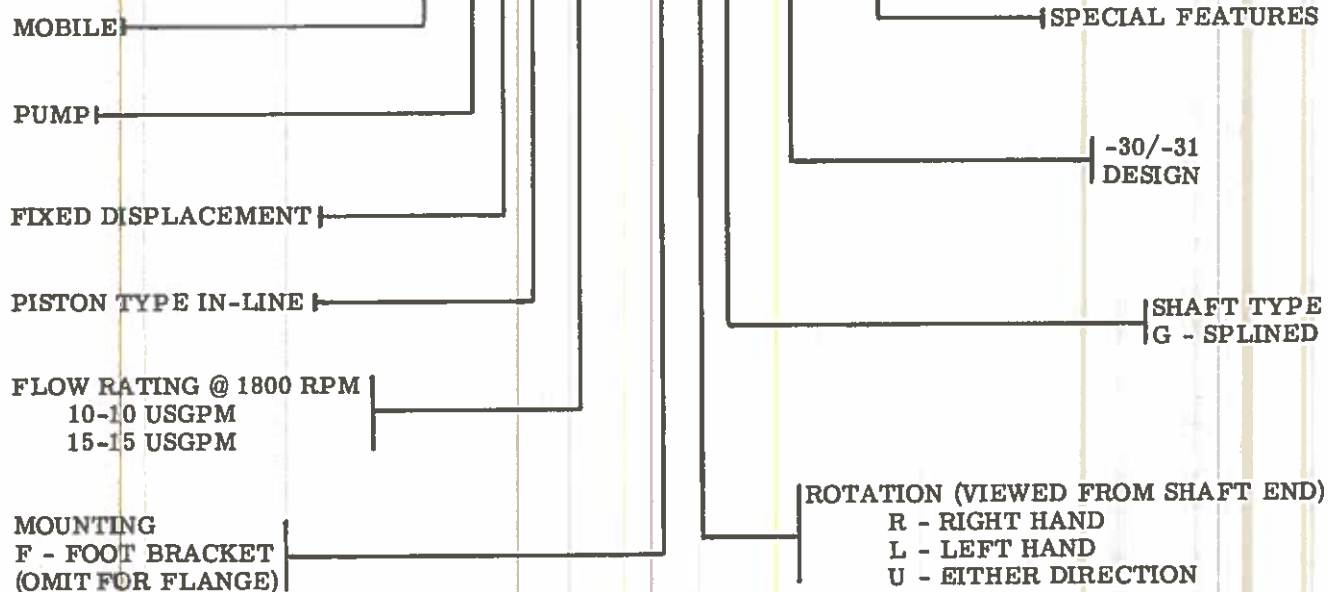
▲INCLUDED IN
919521 SEAL KIT



SEE SERVICE MANUAL M-2200-S FOR MAINTENANCE INFORMATION

MODEL CODE BREAKDOWN

M-PFB**-(*)**-3*-***



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U.S.A.

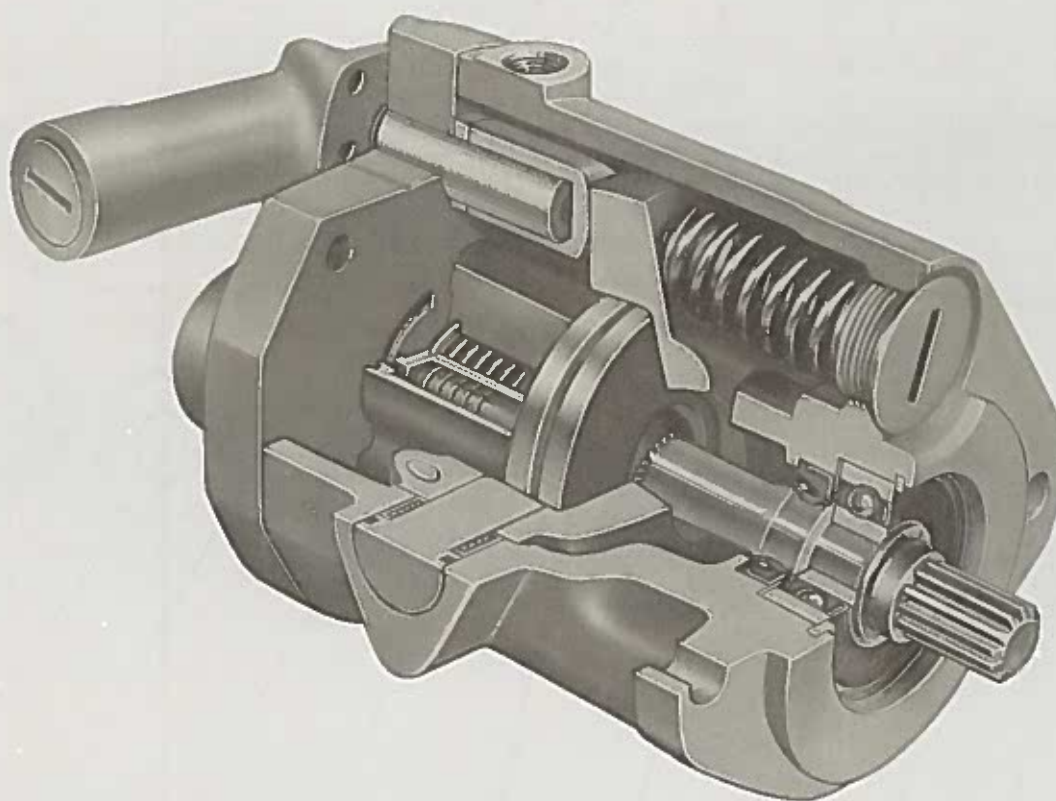
VICKERS

Service Parts Information

Variable
Inline
Piston
Pumps

M-PVB10 & M-PVB15 -21 Design
Compensated Units

20



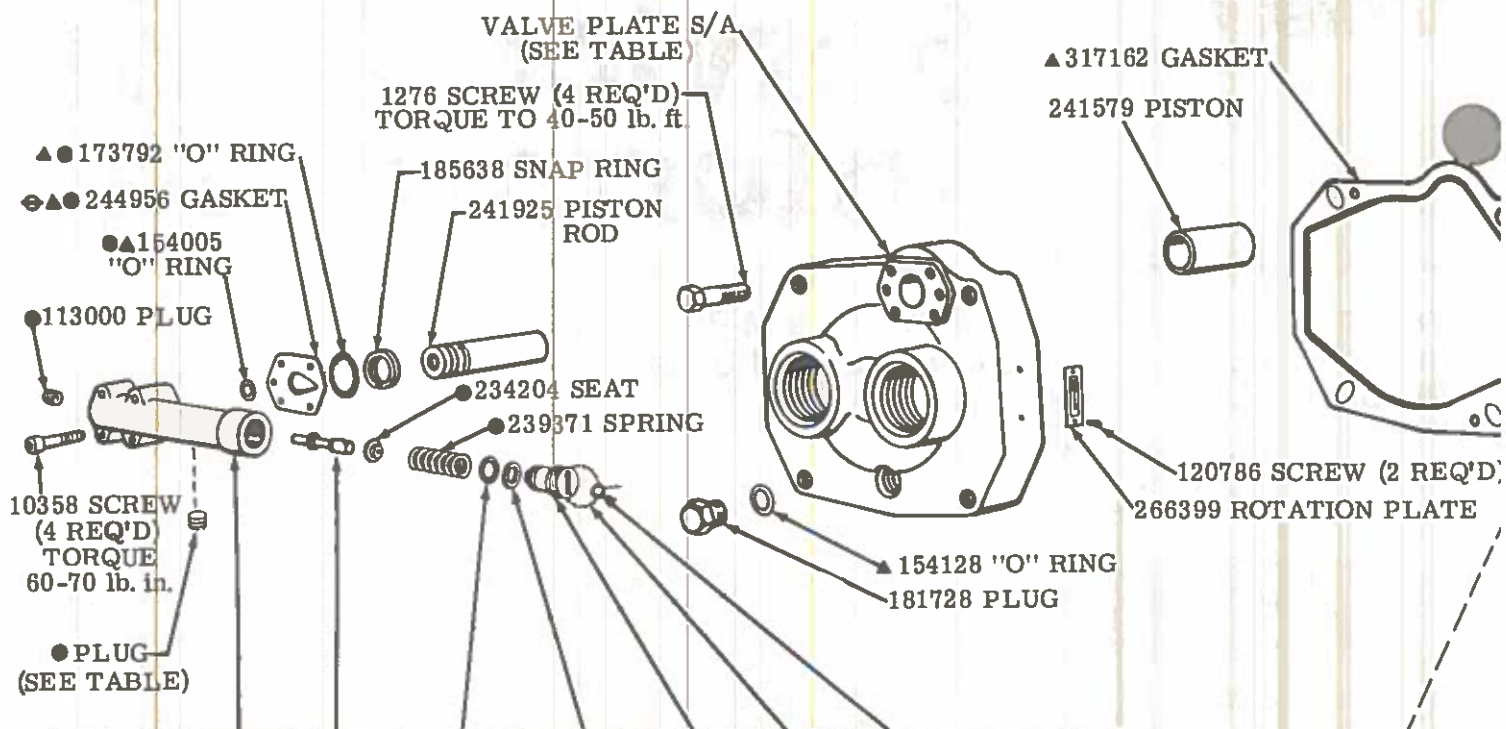
Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

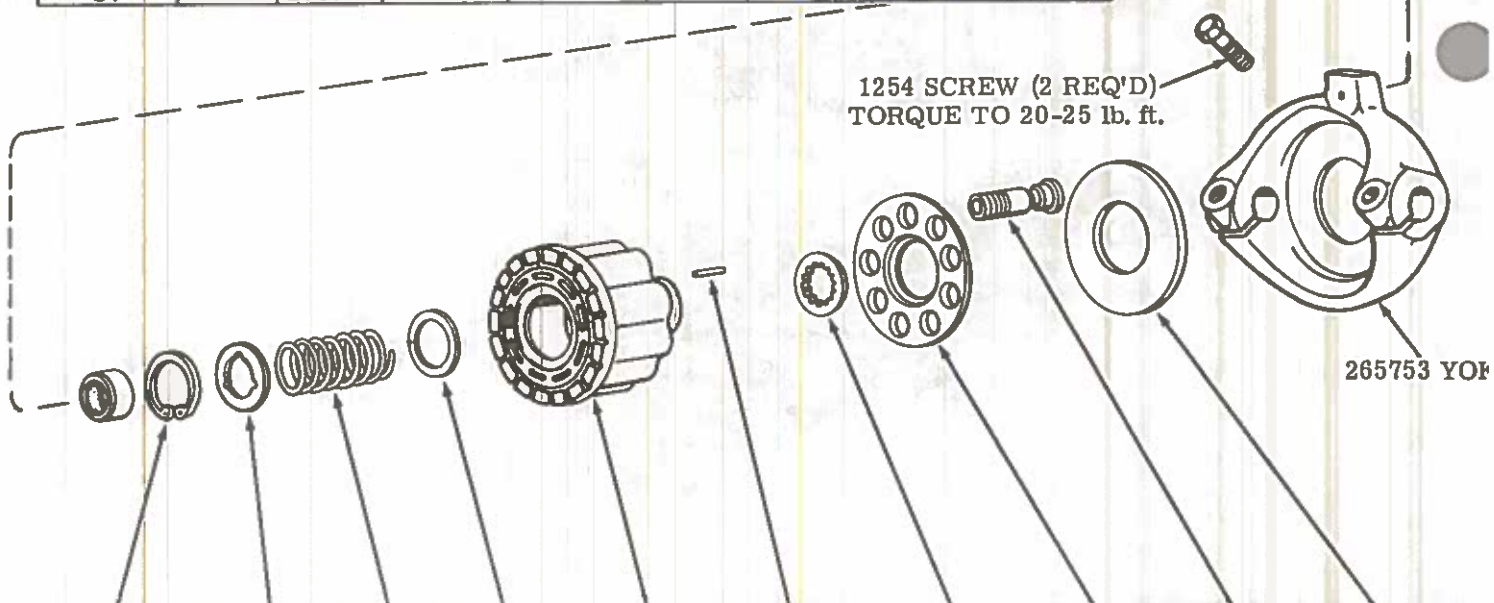
Revised 11-1-85

M-2212-S

A Libbey-Owens-Ford Company



CONTROL TYPE	BODY	SPOOL	"O"RING	BACK-UP RING	PLUG	WIRE	SEAL	PLUG	COMP. KIT
C	241568	241717	▲173792	—	241621	—	—	—	941700
CR		285624							923990
CG	306144	296234	▲173792	287144	386913	17077	17079	7074	923859
CV		278711							923991



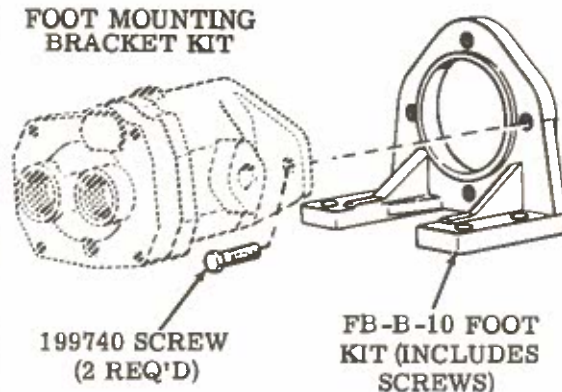
RETAINING RING	LIFT LIMITER	SPRING	THRUST WASHER	CYLINDER BLOCK	PINS (3 REQ'D)	SPHERICAL WASHER	SHOE PLATE	PISTON KIT (9 PISTONS)	SWASH PLATE	ROTOR GROUP
93509	245223	247294	241954	321703 260860	248811	423324	275961	942047 941887	239077	9

THESE PARTS ARE SERVICED IN ROTATING GROUP KIT

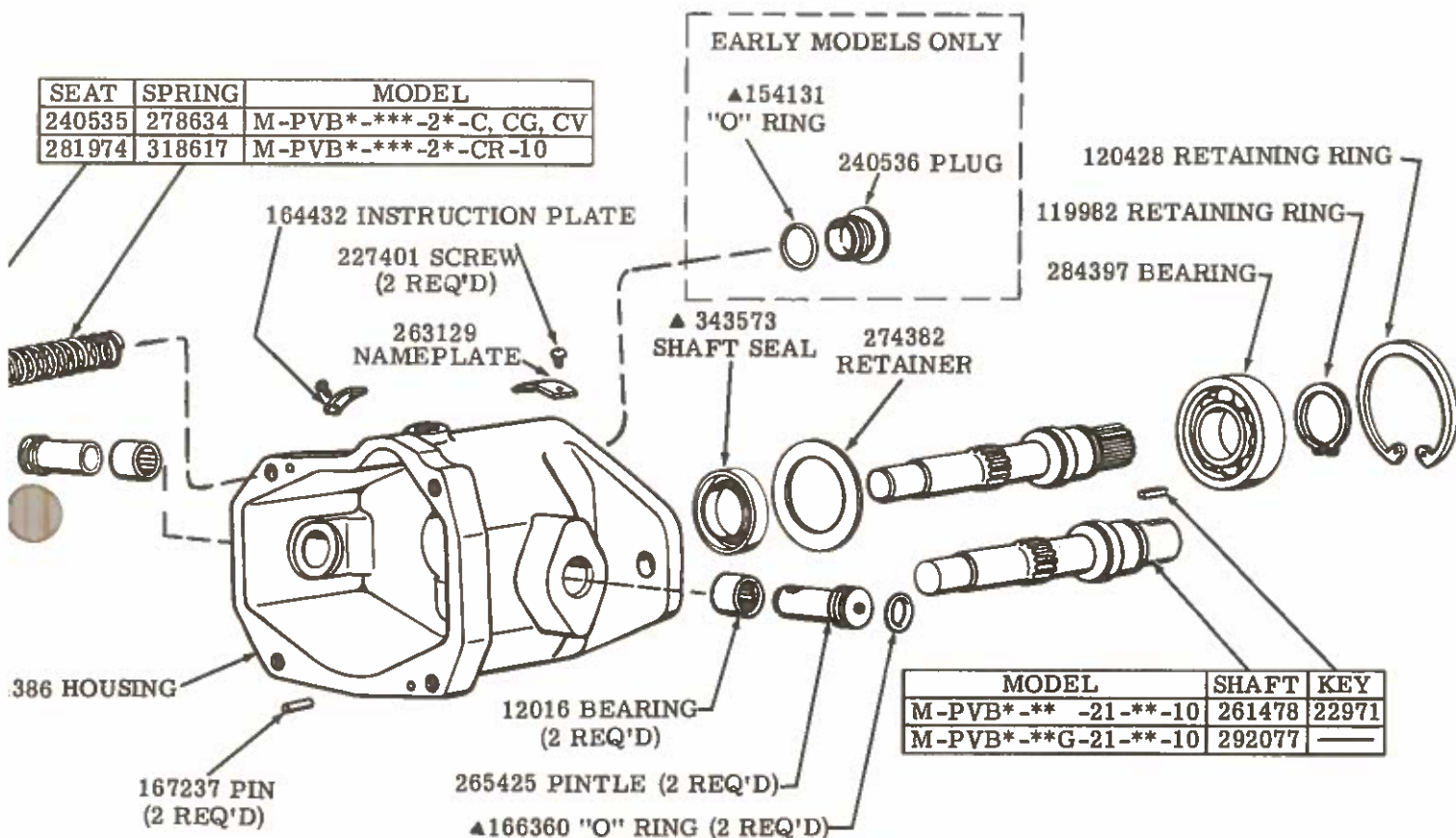
⊕CAUTION
POSITION GASKET WITH SMALL END OF TEARDROP HOLE
POINTING IN DIRECTION OF COMPENSATOR ADJ. PLUG.

VALVE PLATE S/A INCLUDES 12016 BEARING	MODEL
938386	M-PVB10-R**-21-C(*)-10
938385	M-PVB10-L**-21-C(*)-10
938378	M-PVB15-R**-21-C(*)-10
938377	M-PVB15-L**-21-C(*)-10

FOOT MOUNTING BRACKET KIT

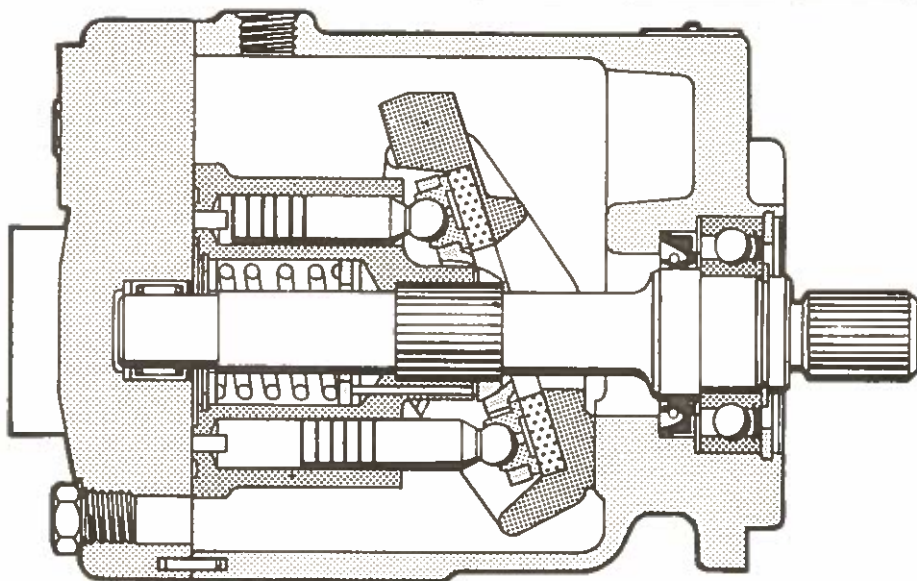


SEAT	SPRING	MODEL
240535	278634	M-PVB*-***-2*-C, CG, CV
281974	318617	M-PVB*-***-2*-CR-10

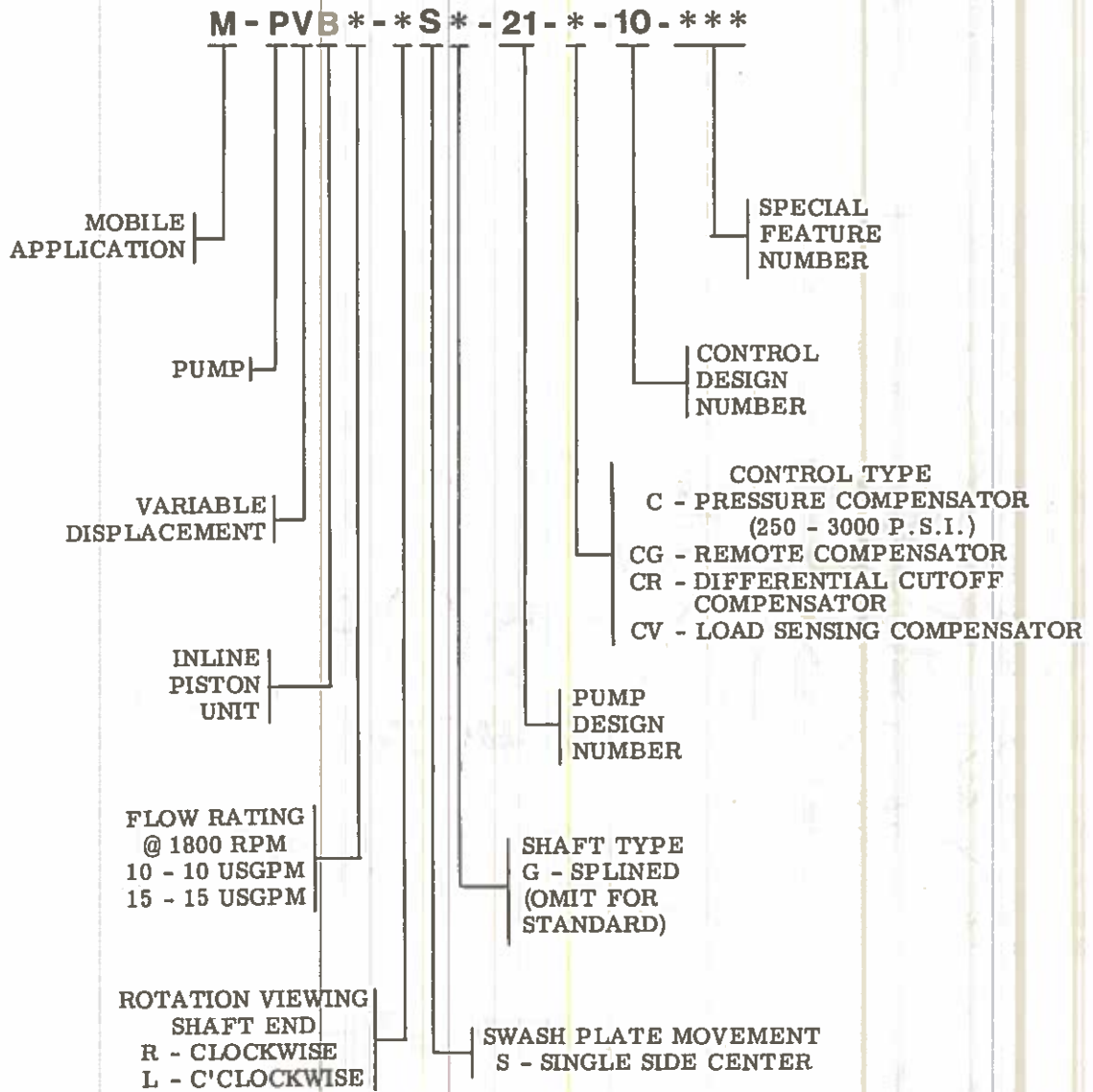


▲INCLUDED IN
SEAL KIT 91912

MODEL
M-PVB10-***-21-**-10
M-PVB15-***-21-**-10



MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 19/15 or cleaner. Selections from Vickers OFFP, OFR, and OFRS series are recommended.

Litho in U.S.A.



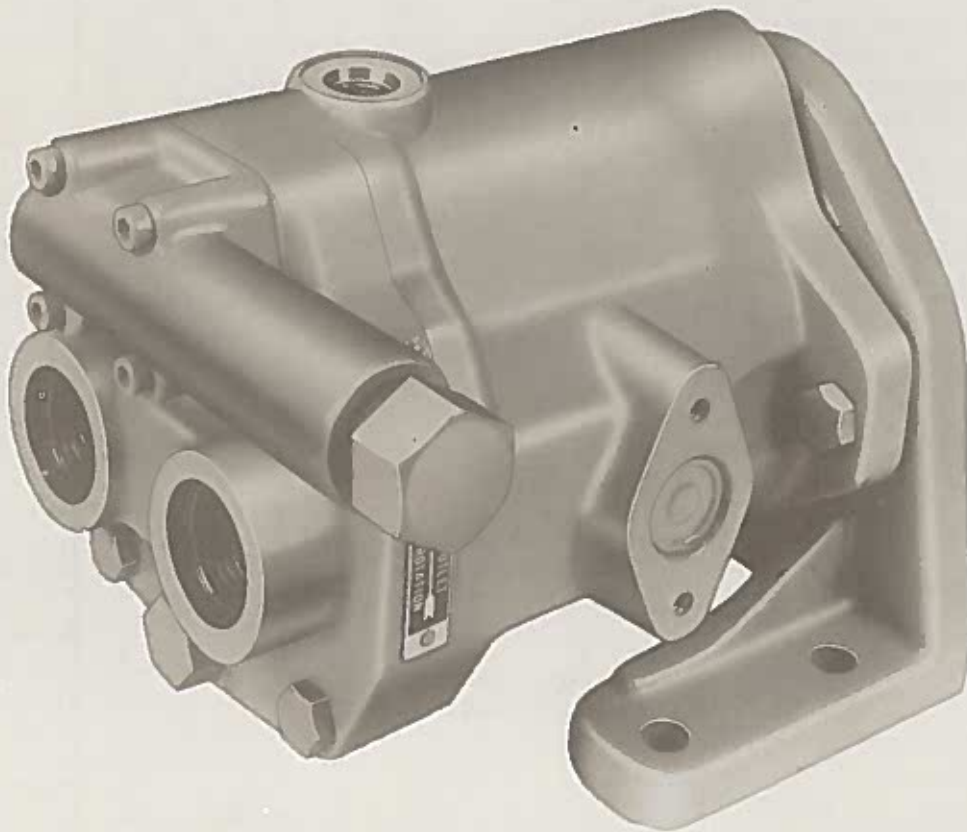
A TRIMOVA COMPANY

Service Parts Information

5 and 6 GPM
Variable Inline
Piston Units

MVB5-(F)UDY-20-*(L)-10
PVB5-(F)**Y-20-*(C)(*)-1*
PVB6-(F)**Y-20-*(C)(*)-1*

21



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 5-1-87

I-3280-S

PRESS BEARING FLUSH
WITH INSIDE SURFACE
OF HOUSING

YOKE

HOUSING

319243 PINTLE
(REF.)

PINTLE BEARING ASSEMBLY NOTE
MAKE CERTAIN THE BEARING O. D. SURFACE
AND THE MATING SURFACE IN THE HOUSING
IS CLEAN. APPLY SEALING COMPOUND
(LOCTITE A (10-1) OR EQUIVALENT) TO THE
BEARING O. D. AND PRESS IN PLACE.

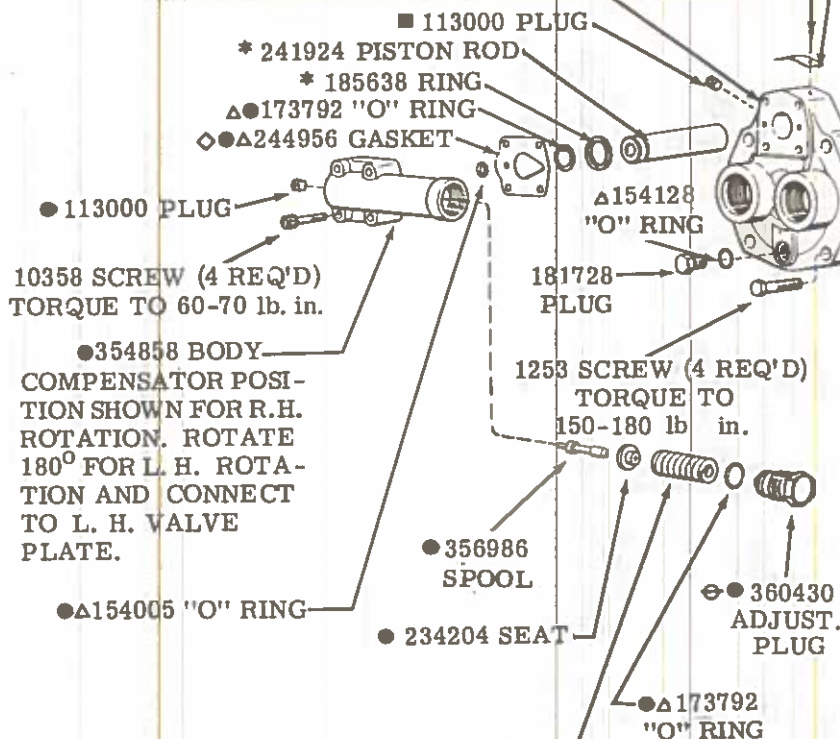
CAUTION
DO NOT ALLOW SEALING COMPOUND
TO CONTACT THE BEARING NEEDLES.

317572
BEARING
(REF.)

BEARING

MODEL
PVB*-SY-20-C

MODEL	VALVE PLATE S/A
PVB*-RSY-20-C(*)-11	942223
PVB*-LSY-20-C(*)-11	942224
PVB*-RDY-20-H/M-10	942225
PVB*-LDY-20-H/M-10	942246
MVB5-UDY-20-H/M-10	942227



PRESSURE RANGE (PSI)	COMPEN- SATOR SUBASSY	SPRING
(C)250-3000 (5)	942158	●239371
⊖250-2000 (6)		
(CM)250-1500	942159	●265693

● INCLUDED IN PRESSURE
COMPENSATOR SUBASSYS
SHOWN IN TABLE.

■ INCLUDED IN
VALVE PLATE S/A

MODEL	RET. RING	LIFT LIMITER	SPRING	THF WAS
PVB5-YY-20				
MVB5-YY-20	165385	273409	274787	275
PVB6-YY-20				

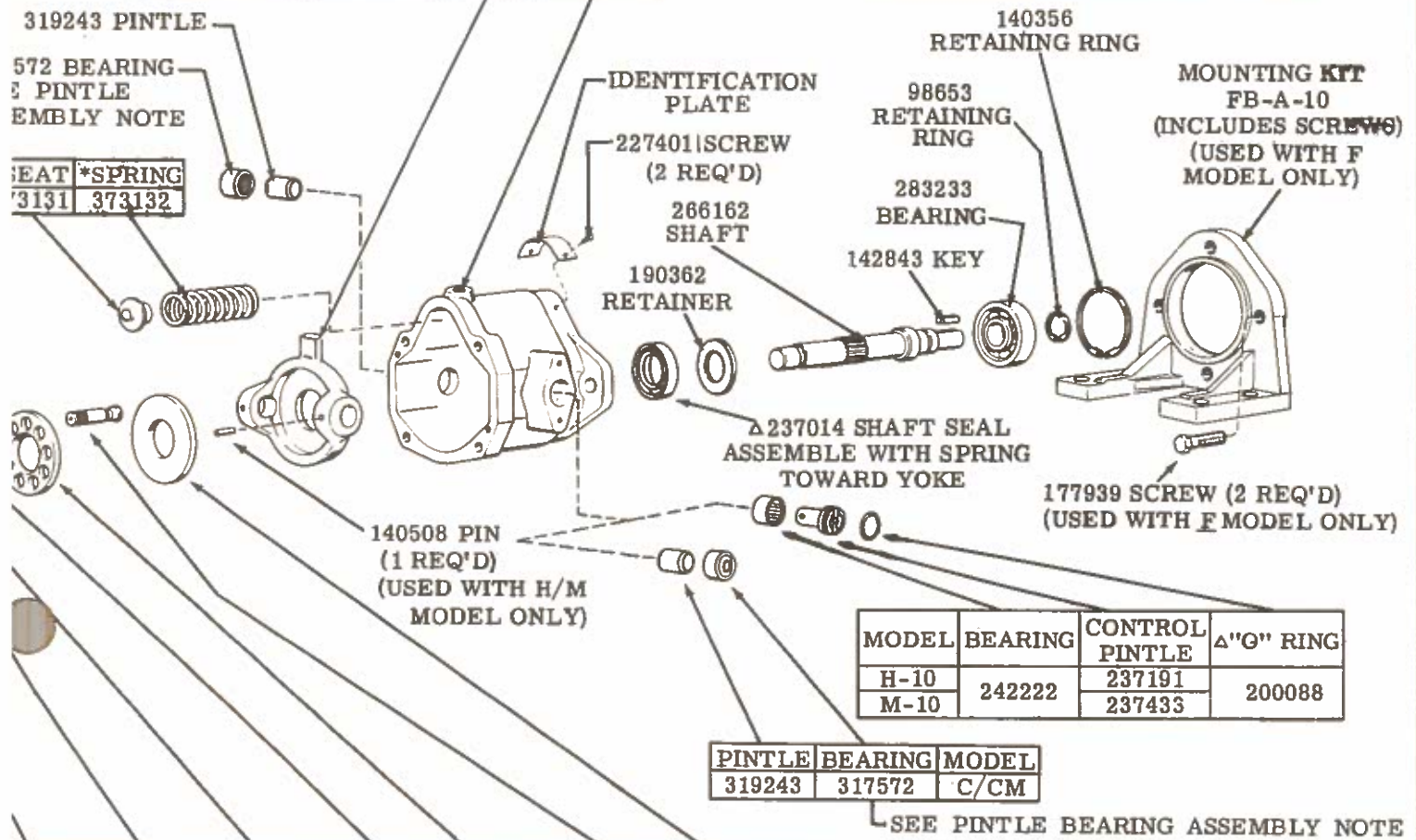
227401 SCREW (HANDWHEEL/LEVER MODE)
227407 SCREW (COMPENSATOR MODELS)
ROTATION PLATE
404751 - COMPENSATOR PUMP MODELS
195060 - HANDWHEEL & LEVER PUMP MO

⊖ CAUTION
MODEL PVB6 COMPENSATOR
PRESSURE ADJUSTMENT SHALL
NOT EXCEED 2000 PSI.

NOTE: TYPE 'C' & 'CM' COMPENSATOR
CONTROL PARTS SHOWN. SEE BACK
PAGE FOR MANUAL CONTROLS. REFER
TO PARTS DRAWING I-3243-S FOR 'CVP'
PRESSURE LIMITING & LOAD SENSING
COMPENSATOR CONTROL.

MODEL	YOKE	HOUSING
PVB*-D*Y-20-H-1*	237192	436462
PVB*-D*Y-20-M-1*		308334
PVB*-S*Y-20-C(*)-1*	231557	

◇CAUTION
POSITION GASKET WITH SMALL END
OF TEARDROP HOLE POINTING IN
DIRECTION OF COMPENSATOR ADJ-
USTING PLUG.



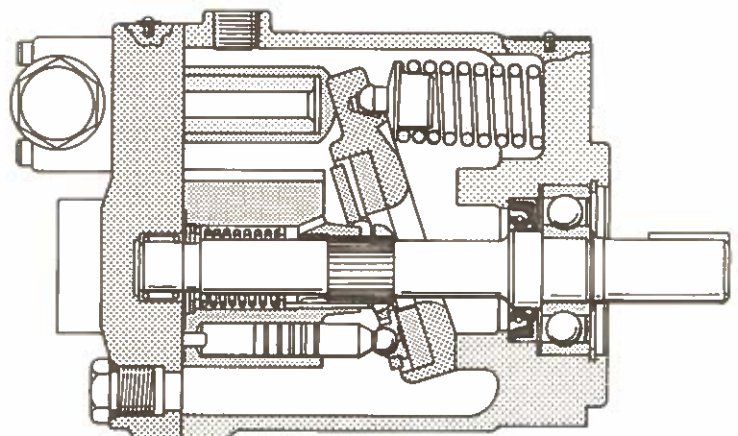
CYL. LOCK	PIN (3 REQ'D)	WASHER	SPHER. WASHER	SHOE PLATE	PISTON S/A KIT	SWASH PLATE	ROTATING GROUP KIT
— THESE PARTS INCLUDED IN —							
74670	248203	274956	275485	274249	942229	319245	938262
16000					942230		938265
15148							938264

F3 EQUIVALENT
SEAL KIT 919308

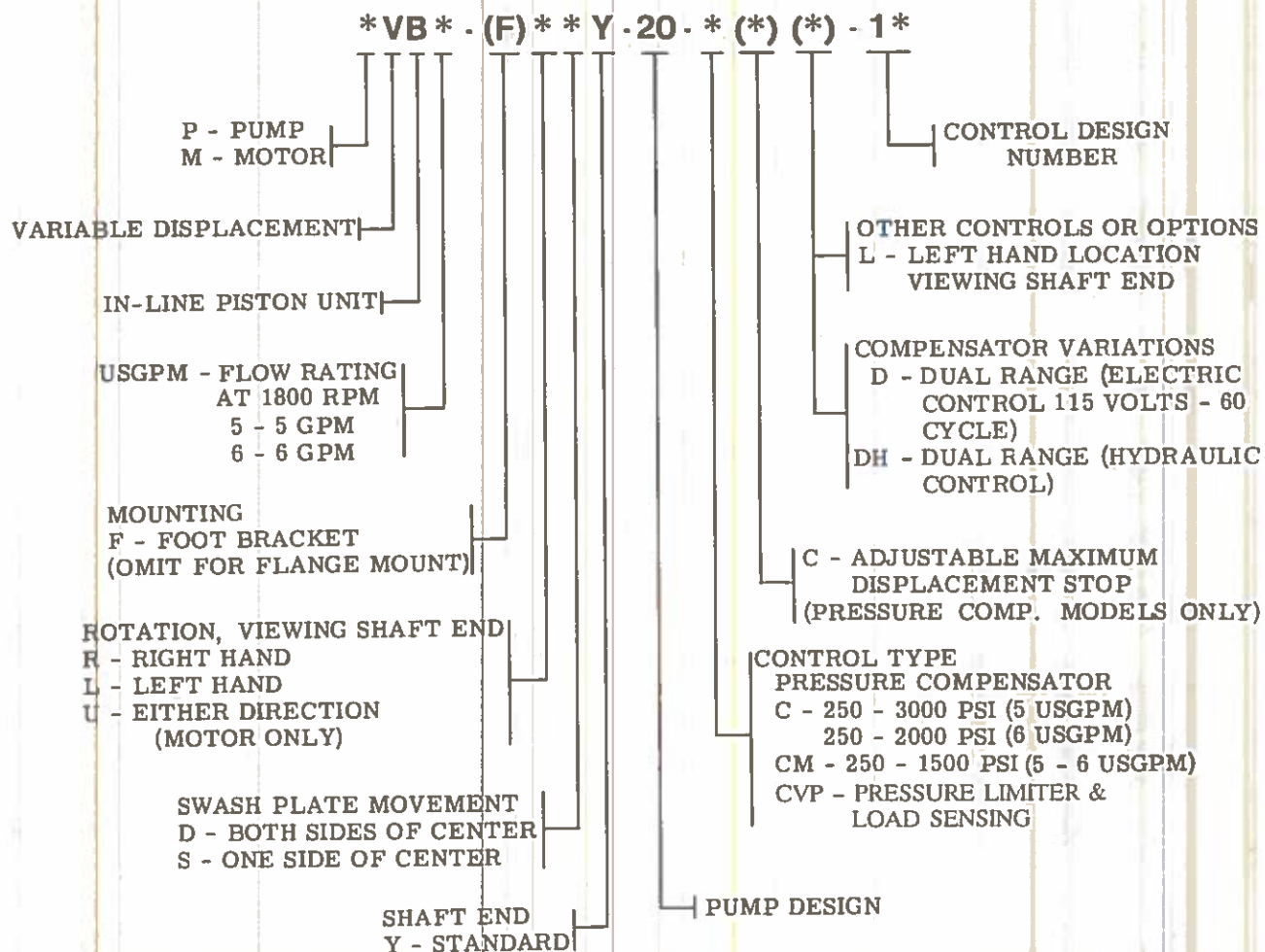
PISTON S/A KIT
INCLUDES 9
PISTON S/A

*USED WITH COMPENSATOR
CONTROL ONLY

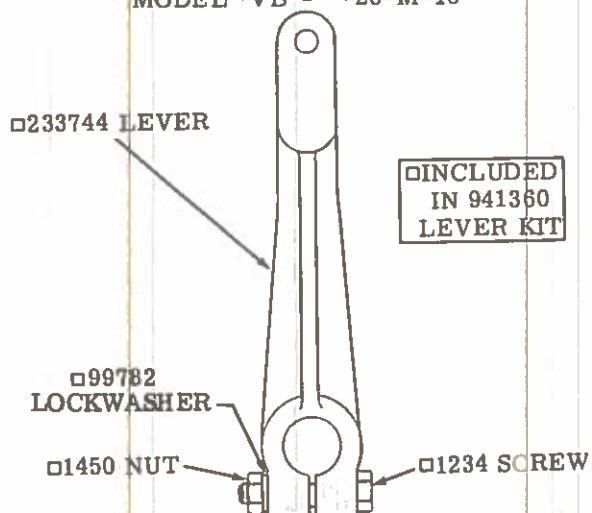
Δ INCLUDED IN
919191 SEAL KIT



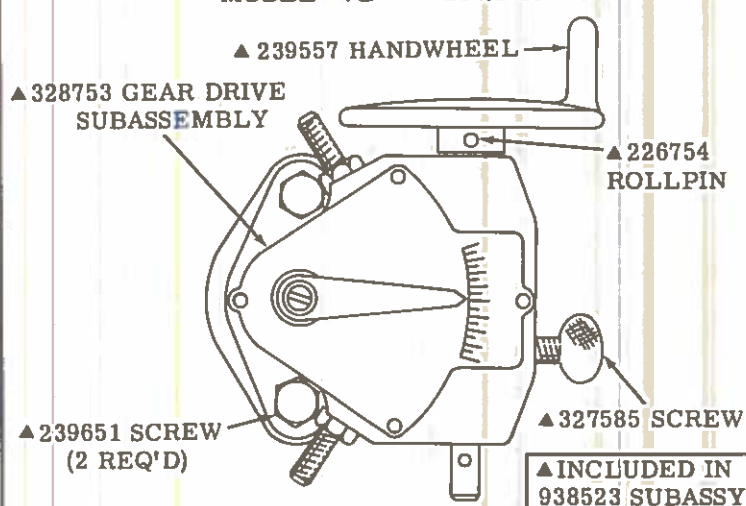
MODEL CODE BREAKDOWN



MANUAL LEVER CONTROL
MODEL *VB*-**-20-M-10



HANDWHEEL CONTROL
MODEL *VB*-**-20-H-10



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U. S. A.

-LABORATORY WORK SHEET-

VARIABLE IN-LINE UNIT

Name _____

 I. PRELIMINARY OBSERVATION

- A. Model number _____
- B. Pump _____ Motor _____
- C. Mounting _____
- D. Direction of rotation _____
- E. Nominal GPM from model number _____ GPM at _____ RPM.
- F. Type of control _____

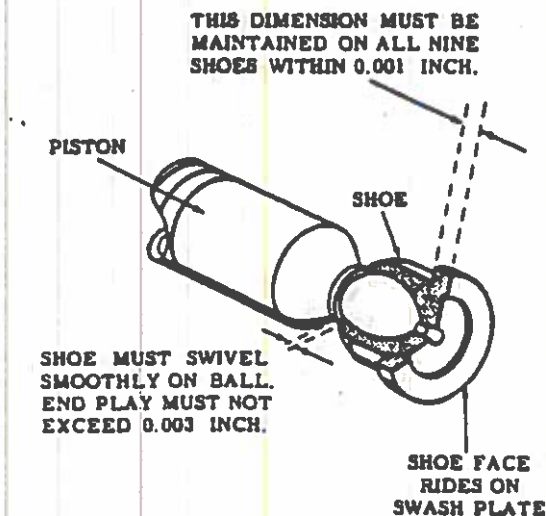
 II. DISASSEMBLY

- A. Lever Control, If Equipped
 - 1. Remove four hex head bolts in valve plate subassembly.
 - 2. Remove valve plate.
- B. Compensator, If Equipped
 - 1. Remove four compensator mounting screws.
 - 2. Remove compensator subassembly and gasket.
 - 3. Disassemble compensator by removing adjusting screw, spring, seat, and spool. Check condition of spool:
Usable _____ Replace _____
 - 4. Remove four hex head bolts in valve plate subassembly.
 - 5. Remove valve plate, spacer, piston rod and piston.
- C. Inspection
 - 1. Examine piston and piston rod assembly of compensator for wear: Usable _____ Replace _____
 - 2. Examine needle bearing for wear: Good _____ Replace _____
 - 3. Examine valve plate face for wear:
Usable _____ Rework _____ Replace _____

Note: Valve plate should not be reworked if pump is operated above 1500 PSI or with fluids other than recommended on installation drawings. Valve plates which can be lapped should be done by hand. Excessive lapping will remove hardened surface.

II. DISASSEMBLY (CONTINUED)

- D. Remove rotating group. Caution: Tilt unit so that drive shaft is horizontal and carefully remove the complete rotating group subassembly.
- E. Disassembly - rotating group
1. Grasp shoe hold down plate and remove all pistons simultaneously from their bores.
 2. Remove spherical washer and flat washer from atop the force transmitting pins.
 3. Remove three pins.
 4. Remove piston subassembly from shoe plate.
 5. Check shoe and piston assembly for end play. (Not to exceed .003".) Usable _____ Replace _____
 6. Check piston shoes. (Maximum allowable variance between all shoes .001".) Usable _____ Rework _____
 7. Check sealing surface on under side of shoes for wear. Usable _____ Rework _____ Replace _____



8. Examine cylinder block face for wear:
Usable _____ Rework _____ Replace _____
(If cylinder block needs lapping, not more than .010" should be removed.)

II. DISASSEMBLY (CONTINUED)

F. Drive shaft removal and inspection.

1. Remove large snap ring at shaft end.
USE CAUTION: Keep snap ring contained.
2. Remove drive shaft and bearing subassembly from housing.
3. Check ball bearing for roughness: Usable____ Replace____
4. Inspect needle bearing and shaft seal contact areas on drive shaft for wear: Usable____ Replace____

III. LIST MISSING PARTS AND NOTIFY INSTRUCTOR

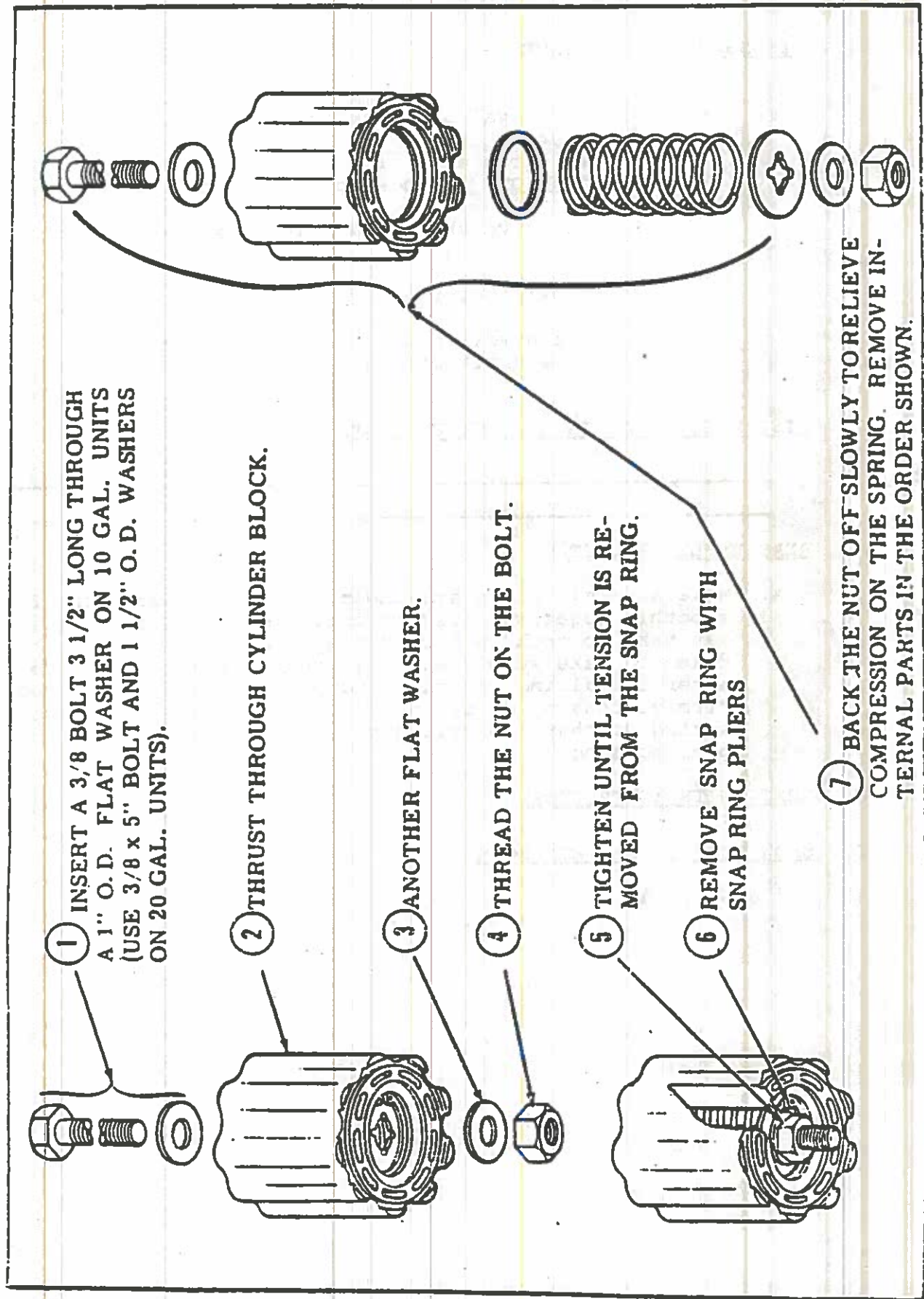
IV. REASSEMBLY OF UNIT

- A. Make sure all parts are clean, free from burrs and fit smoothly together. Use no undue force. Swash plate may tend to cock in bore during reassembly. Care should be taken to make sure that it is properly seated before and after installing rotating group. This can be checked by firmly pressing on cylinder block face and compressing spring so that the cylinder block face is flush with pump housing.

V. CHECK WITH INSTRUCTOR

VI. SHOW PUMP IN GRAPHIC FORM

PROCEDURE FOR CYLINDER BLOCK DISASSEMBLY. (WHEN NECESSARY).



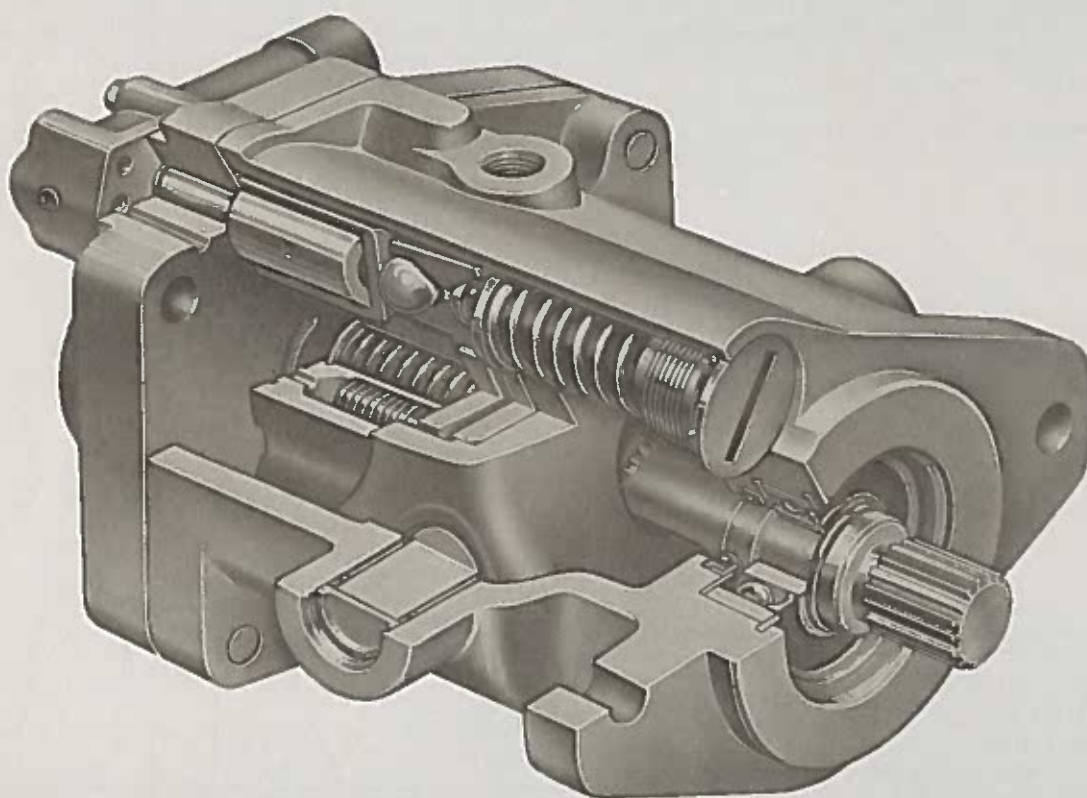
VICKERS

Service Parts Information

Variable
Inline
Piston
Pumps

M-PVB20
M-PVB29
10 Design

22



Vickers, Incorporated

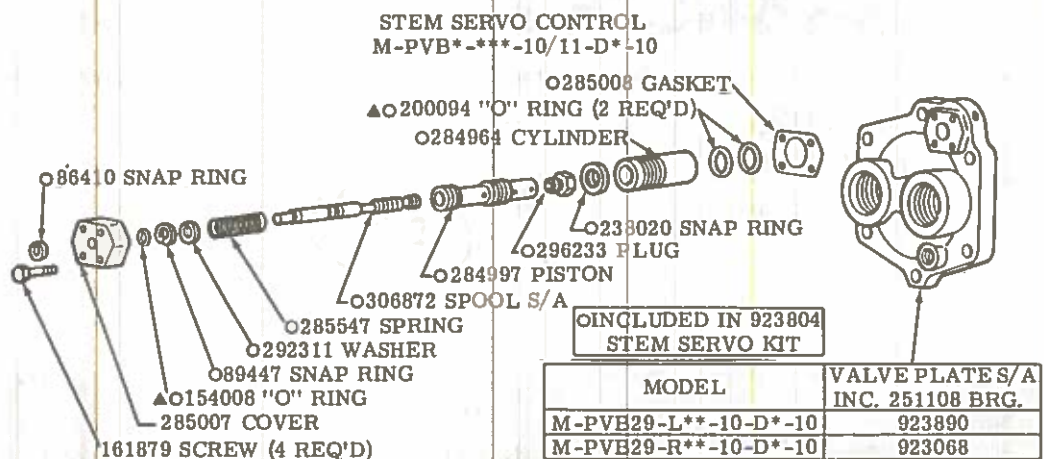
1401 Crooks Road
Troy, Michigan 48084

Revised 11-1-85

M-2213-S

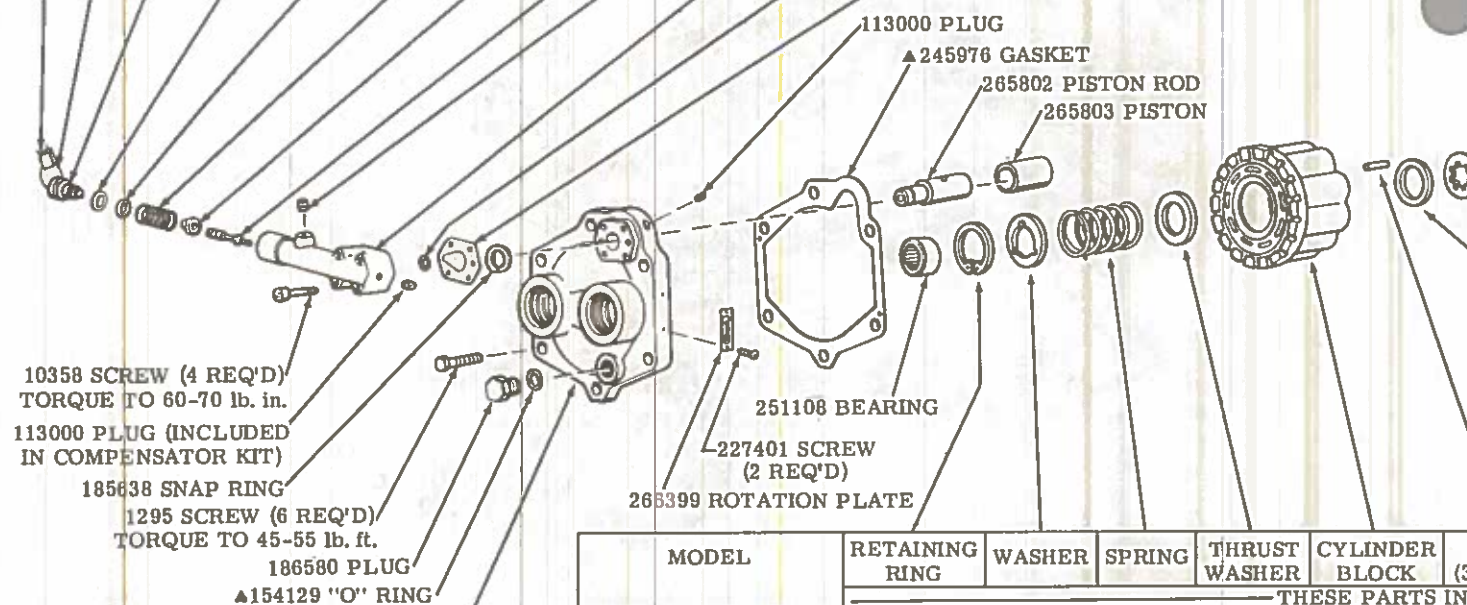
A Libbey-Owens-Ford Company

WARNING: USE THIS DRAWING FOR PARTS INFORMATION ONLY. SEE OVERHAUL MANUAL M-2



WARNING: REMOVE 7074 PL
CONNECT APPROPRIATE CO
VALVE BEFORE STARTING
MENT.

INCLUDED IN COMPENSATOR SUBASSEMBLY KIT													
SEAL	SEAL WIRE	PLUG	BACK UP ▲RING	"O"▲RING	SPRING	SEAT	SPOOL	PLUG	BODY	"O"▲RING	GASKET	COMP. KIT	CONTROL
—	—	241621	—	173792	239371	234204	241717	—	241568	154005	244956	941700	C
							285624					923990	CR
							296234					923859	CG
17079	17077	386913	287144	226140			278711	7074	306144			923991	CV

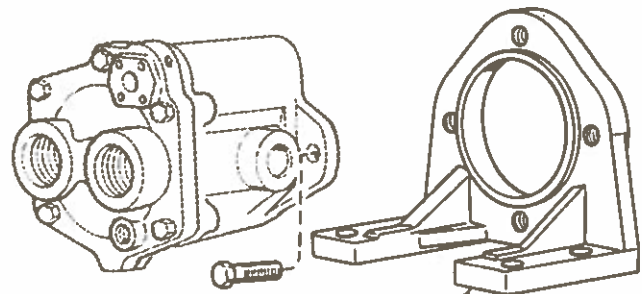


MODEL	VALVE PLATE S/A INC. 251108 BEARING
M-PVB20-R**-10-C-10	938400
M-PVB20-L**-10-C-10	938401
M-PVB29-R**-10-C-10	938404
M-PVB29-L**-10-C-10	938405

MODEL	RETAINING RING	WASHER	SPRING	THRUST WASHER	CYLINDER BLOCK	(3)
M-PVB20-***-10*-10	194025	244931	246386	238780	250688	
M-PVB29-***-10*-10			263582		259458	

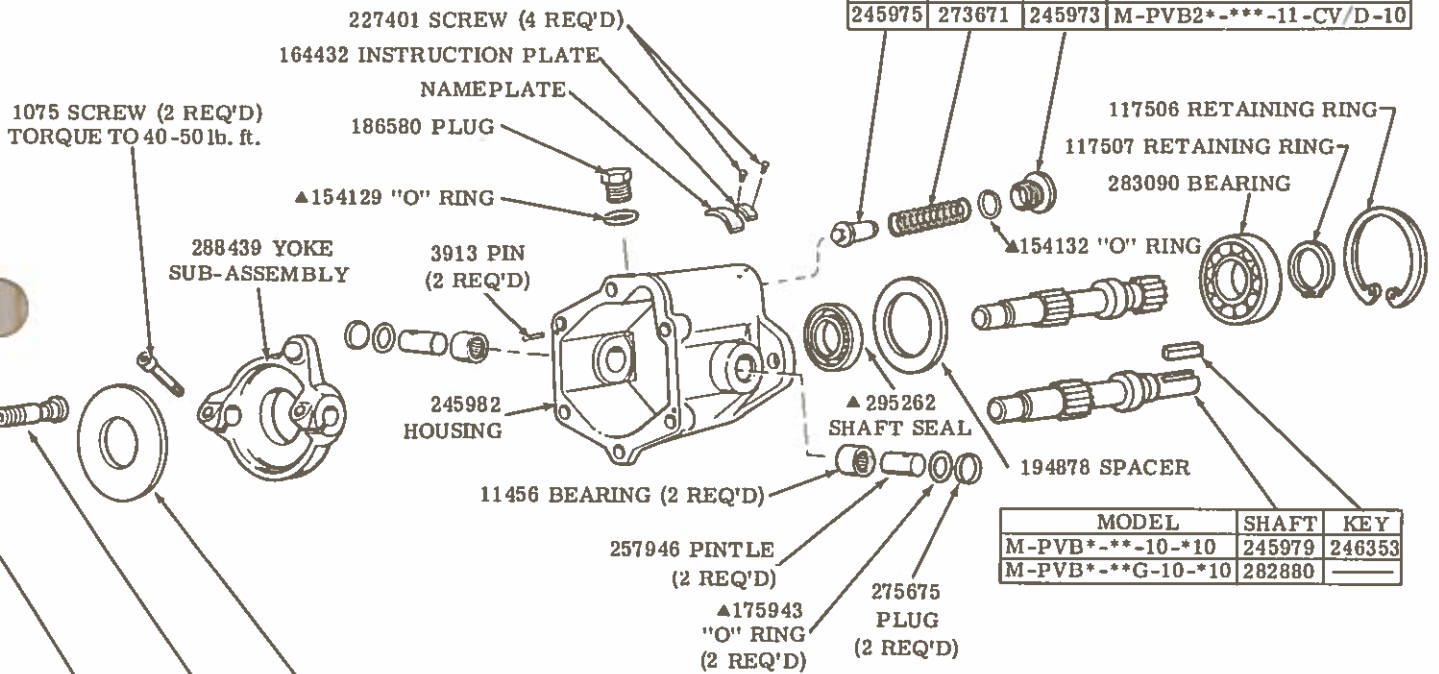
FOR MAINTENANCE INFORMATION

FOOT MOUNTING BRACKET KIT



FB-C-10
(INCLUDES SCREWS)

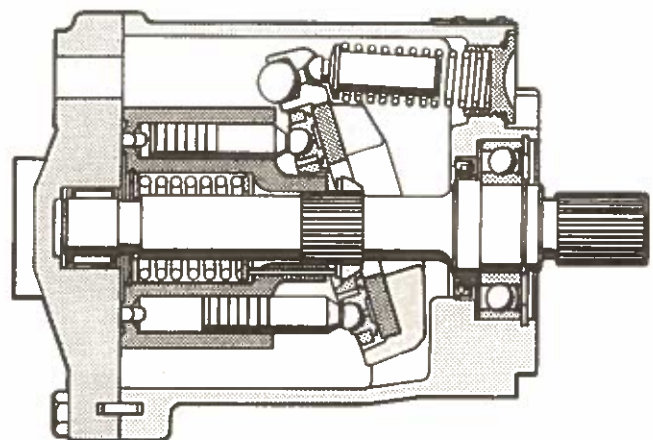
SEAT	SPRING	PLUG	MODEL
245975	273671	245973	M-PVB2*-*-11-C/CG-10
306370	306434	306369	M-PVB2*-*-11-CR-10
245975	273671	245973	M-PVB2*-*-11-CV/D-10



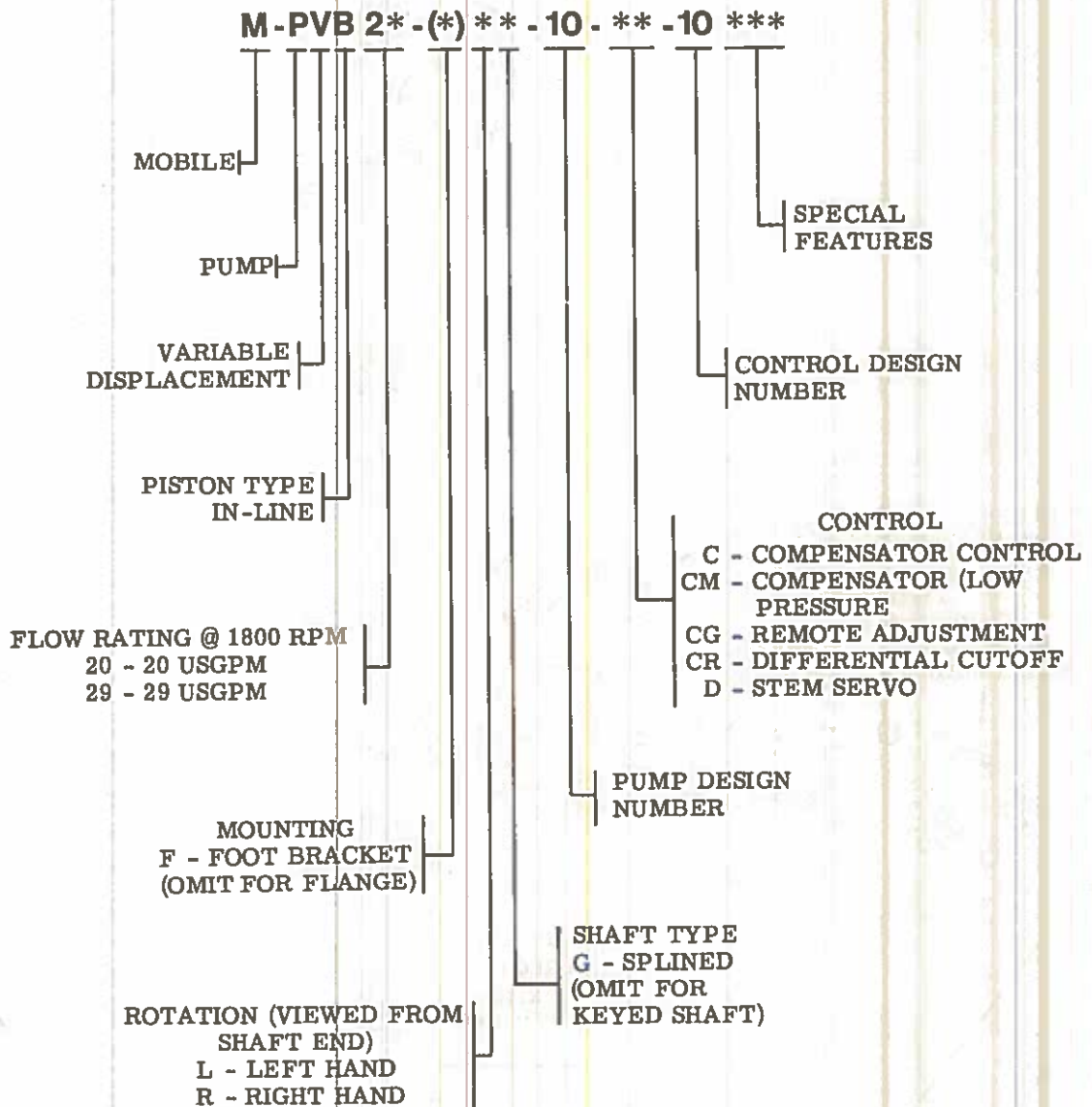
MODEL	SHAFT	KEY
M-PVB*-*-10-*10	245979	246353
M-PVB*-*-G-10-*10	282880	

SPHERICAL WASHERS/A	SHOE PLATE	PISTON KIT (9 PISTONS)	SWASH PLATE	ROTATING GROUP KIT
938392	248609	941883 941888	239335	938280 938290

▲INCLUDED IN
923006 SEAL KIT



MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

Litho in U.S.A.

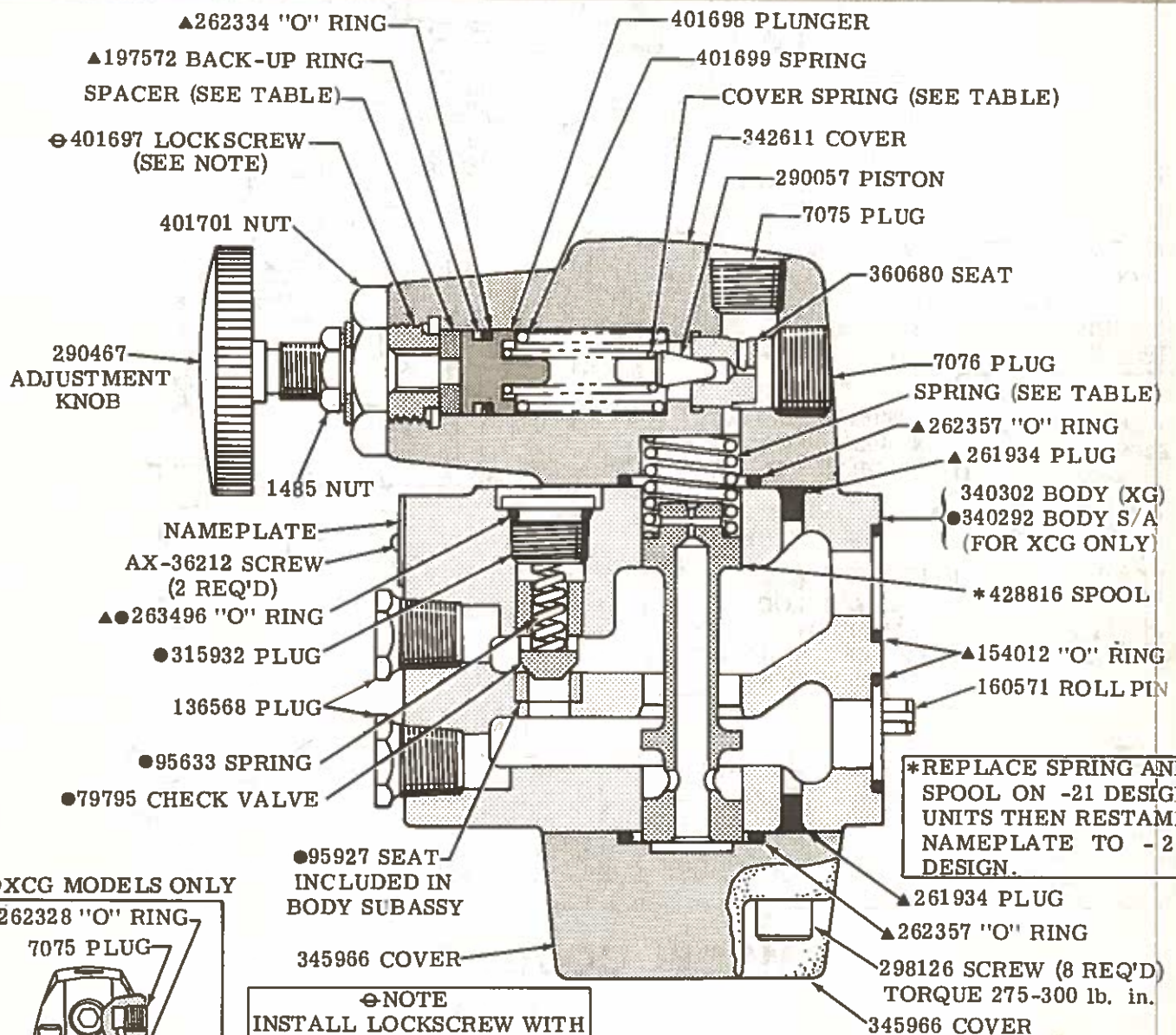
Service Parts Information



PRESSURE REDUCING VALVES

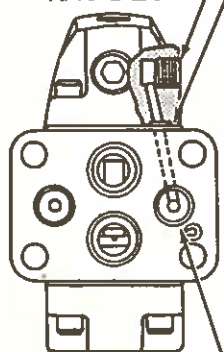
(F3)X(C)T-03-**-21/22

(F3)X(C)G-03-**-21/22



●XCG MODELS ONLY

▲262328 "O" RING
7075 PLUG



▲154008 "O" RING (2 REQ'D)

⊖NOTE
INSTALL LOCKSCREW WITH STEPPED O.D. END TOWARD SPACER OR SPRING RETAINER AS SHOWN.

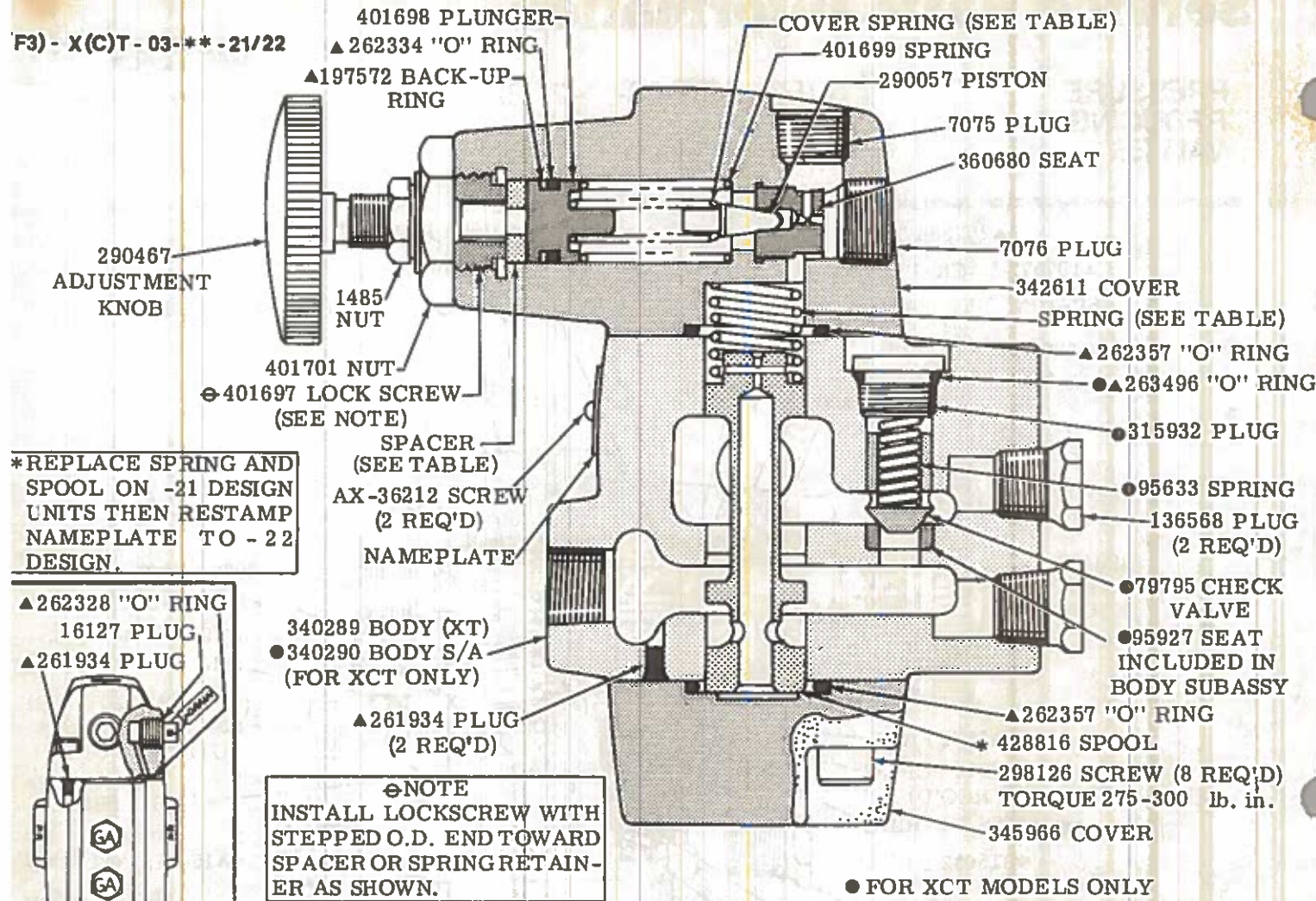
▲INCLUDED IN F3 SEAL KIT 919836

MODEL	* SPRING	COVER SPRING	SPACER	PRESSURE RANGE PSI	RATED FLOW USGPM
X(C)G-03-1B-21/22	428817	2280		75-1000	7
X(C)G-03-1F-21/22	428818			150-1000	14
X(C)G-03-2B-21/22	428817	583937		75-2000	7
X(C)G-03-2F-21/22	428818			150-2000	14
X(C)G-03-3F-21/22		401700	386715	150-2850	

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Revised 11-1-85

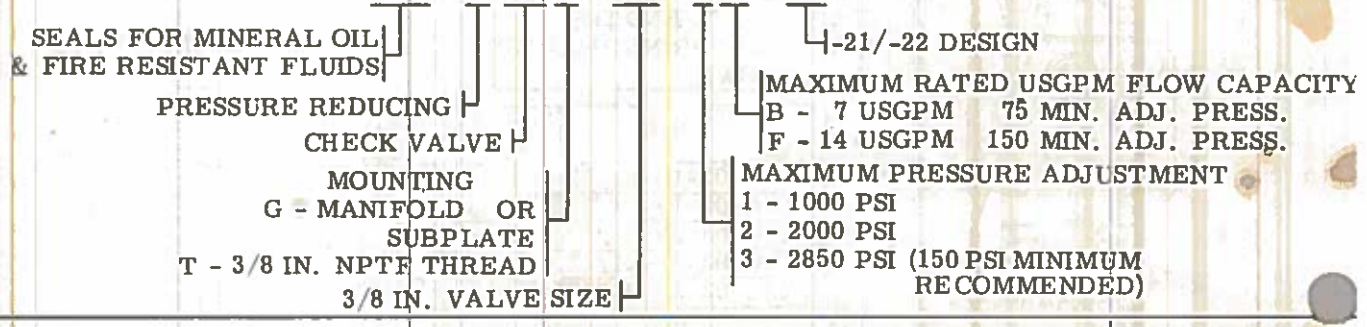
I-3357-S



MODEL	*SPRING	COVER SPRING	SPACER	PRESSURE RANGE PSI	RATED FLOW USGPM
X(C)T-03-1B-21/22	428817	2280		75-1000	7
X(C)T-03-1F-21/22	428818			150-1000	14
X(C)T-03-2B-21/22	428817	583937		75-2000	7
X(C)T-03-2F-21/22	428818			150-2000	14
X(C)T-03-3F-21/22		401700	386715	150-2850	

MODEL CODE BREAKDOWN

(F3) - X (C)* - 03 - ** - 2*



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 18/15 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

**Piston pump
Kolbenpumpe
Pompe à pistons
Pompa a pistoni**

PVH 98 (QI) C-R A F-1-S-10-C 25 VT 18-14

1 2 3 4 5 6 7 8 9 10 11 12 13 13 14

1 PVH Model Series

2 Variable Displacement

98 - 98 cc/r

3 Quiet Version

Blank - Mobile version
QI - Quiet industrial

4 Mounting Flange

C - SAE "C", 4 bolt

**5 Rotation
(Viewed from shaft end)**

R - Clockwise rotation
L - Counterclockwise rotation

6 Configuration (see table)

7 Port Connections

F - SAE flange ports
M - Metric flange ports

**8 Shaft
(see table)**

9 Shaft Seal

S - Single
D - Double

10 Pump Design

**11 Control Options
(see table)**

**12 Pressure Comp. Setting
(Tens of bar)**

25 - 250 bar setting (C)
7 - 70 bar setting (CM)

**13 Torque Limiter Setting
(Tens of bar)**

18 - 180 bar
(Must be 30-80 % of Max. pressure compensator setting)

14 Control Design

30 - C/CV
13 - CT
14 - CVT

1 Baureihe PVH

**2 Verstellbares
Fördervolumen**

98 - 98 cm³/u

3 Leise Ausführung

Leer - Mobil-Version
QI - Leise Industrie-Version

4 Befestigungsflansch

C - SAE "C", 4 Schrauben

**5 Drehrichtung
(Mit Blick auf Wellenende)**

R - Rechtslauf
L - Linkslauf

6 Bauart (siehe tabelle)

7 Systemanschlüsse

F - SAE Flansche
M - Metrische Flansche

**8 Welle
(siehe tabelle)**

9 Wellendichtung

S - Einzeldichtung
D - Doppeldichtung

10 Seriennummer Pumpe

**11 Reglervausführung
(siehe tabelle)**

**12 Reglereinstellung
(in 10 bar stufen)**

25 - 250 bar (C)
7 - 70 bar (CM)

**13 Einstellung Drehmoment-
begrenzer
(in 10 bar Stufen)**

18 - 180 bar
(Muß 30-80 % der max. Regler-
einstellung betragen)

14 Seriennummer Regler

30 - C/CV
13 - CT
14 - CVT

1 Série PVH

2 Cylindrée variable

98 - 98 cm³/tr

3 Version silencieuse

Omis - version mobile
QI - version industrielle silen-
cieuse

4 Bride de montage

C - SAE C à 4 vis

**5 Sens de rotation
(vu du côté arbre)**

R - horaire
L - anti-horaire

**6 Exécution
(Voir le tableau)**

**7 Raccordement des ori-
fices**

F - bride SAE
M - bride métrique

**8 Bout d'arbre
(Voir le tableau)**

9 Joint d'arbre

S - Simple
D - Double

**10 Numéro de dessin de
pompe**

**11 Choix de commandes
(Voir le tableau)**

**12 Tarage du compensateur
de pression
(en dizaines de bar)**

25 - 250 bar (C)
7 - 70 bar (CM)

**13 Réglage du limiteur de
couple
(en dizaines de bar)**

18 - 180 bar
(Obligatoirement 30 à 80% du
tarage maxi. de compensateur)

**14 Numéro de dessin de la
commande**

30 - C/CV
13 - CT
14 - CVT

1 Modello serie PVH

2 Cilindrata variabile

98 - 98 cc/r

3 Versione silenziosa

Vuoto - versione appl. mobile
QI - Versione silenziosa appl. in-
dustriali

4 Flangia di montaggio

C - 4 fori SAE "C"

**5 Rotazione
(vista dal lato albero)**

R - Rotazione oraria
C - Rotazione antioraria

**6 Configurazione
(vedi tabella)**

7 Bocche di connessione

F - attacchi flangiati SAE
M - attacchi a flangia metriche

**8 Albero
(vedi tabella)**

9 Guarnizione albero

S - Singola
D - Doppia

10 Serie pompa

**11 Opzioni sul controllo
(vedi tabella)**

**12 Taratura del compensatore
di pressione
(in decine di bar)**

Pressione di taratura da 25 a 250
bar (C)
Pressione di taratura da 7 a 70
bar (CM)

**13 Taratura del limitatore di
coppia (in decine di bar)**

da 18 a 180 bar
(deve essere compresa dal 30
all'80% del massimo valore tara-
to sul compensatore)

14 Serie

30 - C/CV
13 - CT
14 - CVT

6 Configuration

Blank - Non thru drive
A - SAE "A" pad thru drive
B - SAE "B" pad thru drive
C - SAE "C" pad thru drive

8 Shaft

1 - SAE C Straight keyed
2 - SAE C Splined
3 - SAE CC Splined
13 - SAE CC Straight keyed

6 Bauart

Leer - Ohne durchg. Welle
A - SAE "A" Befestigung für durchg. Welle
B - SAE "B" Befestigung für durchg. Welle
C - SAE "C" Befestigung für durchg. Welle

8 Welle

1 - SAE "C" zylind. mit Paßfeder
2 - SAE "C" verzahnte Welle
3 - SAE "CC" verzahnte Welle
13 - SAE "CC" zylind. mit Paßfeder

6 Exécution

Omis - sans entraînement traversant
A - entraînement traversant avec plan de pose SAE A
B - entraînement traversant avec plan de pose SAE B
C - entraînement traversant avec plan de pose SAE C

8 Bout d'arbre

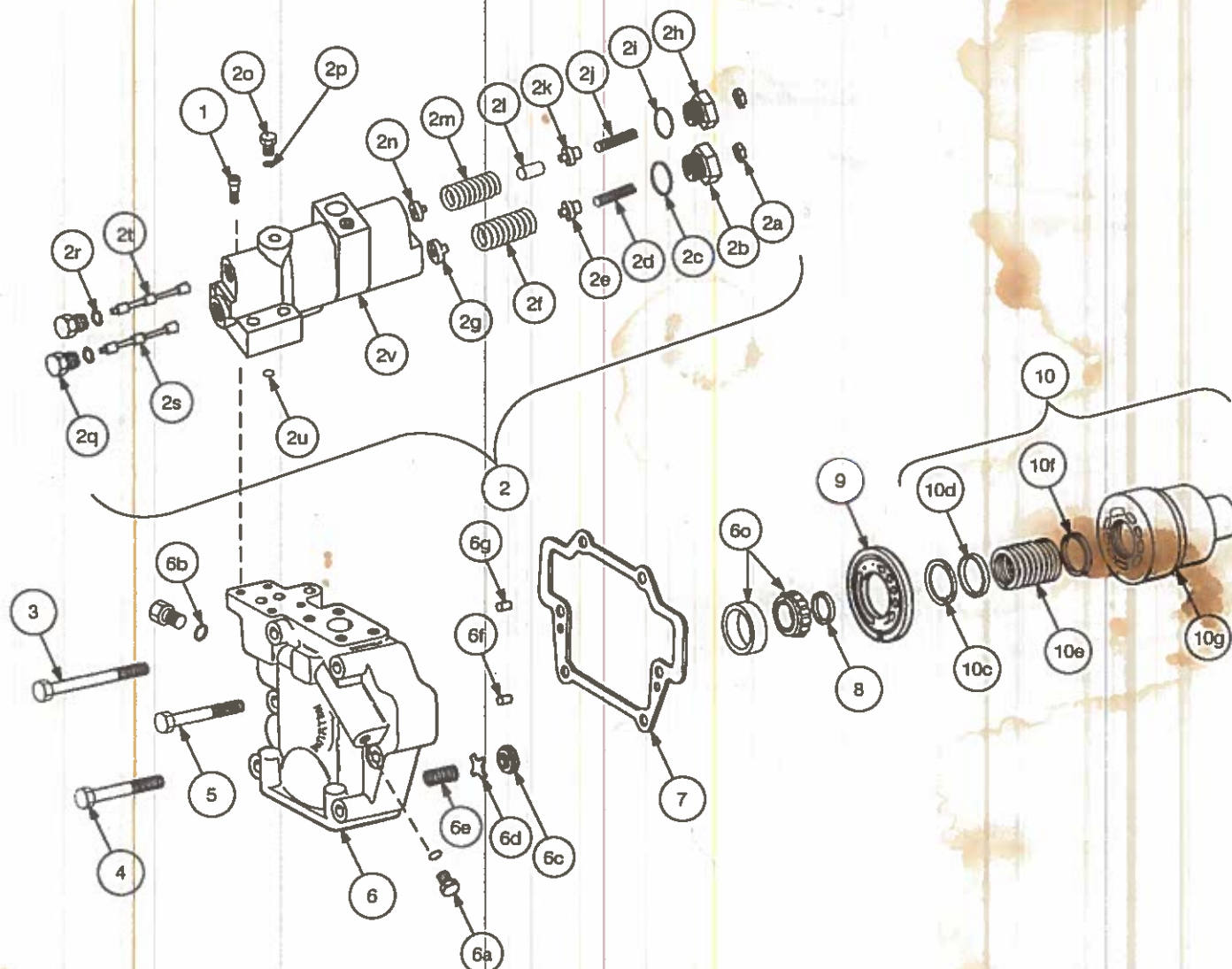
1 - cylindrique claveté SAE C
2 - cannelé SAE C
3 - cannelé SAE CC
13 - cylindrique claveté SAE CC

6 Configurazione

Vuoto - Albero non passante
A - Albero passante con flangia SAE "A"
B - Albero passante con flangia SAE "B"
C - Albero passante con flangia SAE "C"

8 Albero

1 - Cilindrico con chiavetta SAE "C"
2 - Scanalato SAE "C"
3 - Scanalato SAE "CC"
13 - Cilindrico con chiavetta SAE "CC"



11 Control Options

C - Pressure Compensator STD.
CM - Pressure Compensator
C**V - Pressure Compensator with load sensing
C**T** - Pressure Compensator with torque limiter
C**VT** - Pressure Compensator with torque limiter & load sense

11 Reglervausführung

C - Druckregler (Standard)
CM - Druckregler
C**V - Druckregler mit Load sensing
C**T** - Druckregler mit Drehmomentbegrenzer
C**VT** - Druckregler mit Drehmomentbegrenzer und Load sensing

11 Choix de commandes

C - compensateur de pression standard
CM - compensateur de pression
C**V - compensateur de pression "load-sensing"
C**T** - compensateur de pression avec limiteur de couple
C**VT** - compensateur de pression "load-sensing" avec limiteur de couple

11 Opzioni sul controllo

C - Compensatore di pressione standard
CM - Compensatore di pressione
C**V - Compensatore di pressione con rilevatore di carico
C**T** - Compensatore di pressione con limitatore di coppia
C**VT** - compensatore di pressione con limitatore di coppia e rilevatore di carico

Item Pos. Rep. Pos.	Part no. Teile-Nr. N° de pièce No. pezzo	Description	Bezeichnung	Désignation	Descrizione
1	473763 (4)	Screw	Schraube	Vis	Vite
2	See table	Control S/A kit	Baugruppe Regler	Kit de sous-ensemble de commande	Kit controllo S/A
2a	855564 (2)	Nut	Mutter	Ecrou	Dado
2b	857677	Plug	Stopfen	Bouchon	Tappo
2c	154131 ▲	O-ring	O-Ring	Joint torique	O-Ring
2d	857678	Adjustment screw	Einstellschraube	Vis de réglage	Vite di regolazione
2e	857734	Spring guide	Federführung	Guide de ressort	Guida della molla
2f	See table	Control spring	Reglerfeder	Ressort de commande	Molla di regolazione
2g	857734	Spring guide	Federführung	Guide de ressort	Guida della molla
2h	857676	Plug	Stopfen	Bouchon	Tappo
2i	154130 ▲	O-ring	O-Ring	Joint torique	O-Ring
2j	857678	Adjustment screw	Einstellschraube	Vis de réglage	Vite di regolazione
2k	857674	Spring guide	Federführung	Guide de ressort	Guida della molla
2l	857679	Pin	Stift	Goupille de positionnement	Spina
2m	See table	Load spring	Steuerfeder	Ressort de charge	Molla di carico
2n	857764	Spring guide	Federführung	Guide de ressort	Guida della molla
2o	181728	Plug	Stopfen.	Bouchon	Tappo
2p	154128 ▲	O-ring	O-Ring	Joint torique	O-Ring
2q	See table	Plug	Stopfen	Bouchon	Tappo
2r	See table ▲	O-ring	O-Ring	Joint torique	O-Ring
2s	857672	Pressure limiter spool	Druckbegrenzer-Kolben	Tiroir de limiteur de pression	Cursore limitatore di pressione
2t	857673	Load sense spool	"Load sensing"-Kolben	Tiroir de détection de charge	Cursore di rilevazione carico
2u	177969 (3)	O-ring	O-Ring	Joint torique	O-Ring
2v	857722	Body (C/CM)	Körper (C/CM)	Corps (C/CM)	Corpo (C/CM)
	857733	Body (CV)	Körper (CV)	Corps (CV)	Corpo (CV)
3	514574	Screw	Schraube	Vis	Vite
4	514573 (4)	Screw	Schraube	Vis	Vite
5	690406	Screw	Schraube	Vis	Vite
6	See table *	Valve block	Ventilblock	Bloc de distribution	Blocco valvola
6a	689461 (2)	Plug	Stopfen	Bouchon	Tappo
6b	154125 (2) ▲	O-ring	O-Ring	Joint torique	O-Ring
6c	402643	Seat	Sitz	Siège	Sede
6d	402644	Poppet	Kegel	Clapet	Otturatore
6e	584455	Spring	Feder	Ressort	Molla
6f	248935	Pin	Stift	Goupille de positionnement	Spina
6g	471512 (2)	Pin	Stift	Goupille de positionnement	Spina
6h	526669	■ Bias piston	Haltekolben	Piston de maintien	Pistone di reazione
6i	526666	■ Spring	Feder	Ressort	Molla
6j	513600	■ Bias rod	Haltestange	Tige de maintien	Asta di reazione
6k	200104 ▲	O-ring	O-Ring	Joint torique	O-Ring
6l	526627	■ Control Piston	Reglerkolben	Piston de commande	Pistone di controllo
6m	526628	■ Control rod	Reglerstange	Tige de commande	Asta di controllo
6n	200104 ▲	O-ring	O-Ring	Joint torique	O-Ring
6o	413603	■ Bearing	Lager	Roulement	Cuscinetto
7	513631	■ Gasket	Dichtung	Joint	Guarnizione
8	941441	■ Shaft spacer kit	Scheibensatz	Kit de cales d'épaisseur pour arbre	Insieme distanziale albero
9	See table	Valve plate	Ventilplatte	Glace de distribution	Piastra di distribuzione
10	877422	● Rotating group kit	Rotationsbaugruppe	Ensemble rotatif	Kit gruppo rotante
10a	473764 (4) ●	Screw	Schraube	Vis	Vite
10b	513625 (2) ●	Limitter	Distanzstück	Limiteur	Limitatore
10c	102038	● Retaining ring	Sprengtring	Bague de maintien	Anello di arresto
10d	584547	● Spring guide	Federführung	Guide de ressort	Guida della molla
10e	627192	● Spring	Feder	Ressort	Molla
10f	584546	● Spring guide	Federführung	Guide de ressort	Guida della molla
10g	680627	● Cylinder block	Zylinderblock	Barillet	Blocco cilindri
10h	926246	● Piston kit	Kolbensatz	Jeu de pistons	Kit pistone
10i	584539	● Shoe cage	Schuhkäfig	Plaque de poussée	Piastra portapattino
11	527167	Shaft (type 1)	Welle (Typ 1)	Arbre (type 1)	Albero (tipo 1)
	513627	Shaft (type 2)	Welle (Typ 2)	Arbre (type 2)	Albero (tipo 2)
	864453	Shaft (type 3)	Welle (Typ 3)	Arbre (type 3)	Albero (tipo 3)
	864454	Shaft (type 13)	Welle (Typ 13)	Arbre (type 13)	Albero (tipo 13)
11a	114516	Key (type 1)	Paßfeder (Typ 1)	Clavette (type 1)	Chiavetta (tipo 1)
12	513625 (2)	Spacer	Distanzstück	Entretoise	Distanziale
13	513602	Plug	Stopfen	Bouchon	Tappo
14	396102 ▲	O-ring	O-Ring	Joint torique	O-Ring
15	470793 (3)	Screw	Schraube	Vis	Vite
16	513347	Cover	Deckel	Couvercle	Coperchio
17	355659 ▲	O-ring	O-Ring	Joint torique	O-Ring
18	513629	Yoke S/A	Baugruppe Schrägscheibe	Sous-ensemble d'étrier	Piastra oscillante S/A
19	690339 (2) ■	Screw	Schraube	Vis	Vite
20	513911	■ Saddle bearing	Sattellager	Demi-coquille	Semisede del cuscinetto
21	513912	■ Saddle bearing	Sattellager	Demi-coquille	Semisede del cuscinetto
22	388154	■ Bearing	Lager	Roulement	Cuscinetto
23	126911	Retaining ring	Sprengtring	Circilips	Anello di arresto
24	589332	Shaft seal	Wellendichtring	Joint d'arbre	Guarnizione dell'albero
25	181792	Plug	Stopfen	Bouchon	Tappo
26	396100 ▲	O-ring	O-Ring	Joint torique	O-Ring
27	594329	Nameplate	Typenschild	Plaque signalétique	Piastrina
28	513645 *	Housing (single seal)	Gehäuse (Einzeldichtung)	Carter (joint simple)	Corpo (con singola guarnizione)
	864341 *	Housing (double seal)	Gehäuse (Doppeldichtung)	Carter (joint double)	Corpo (con doppia guarnizione)

* Not available for sale

- ▲ Available in single shaft seal kit 02-102263
Equivalent double shaft seal kit 02-102264
- Available in rotating group kit* 877422
- Available in bearing kit 877425
- ◇ Omit on C control S/A
- See assembly instructions
- ⊞ See assembly note

* Nicht lieferbar

- ▲ Erhältlich als Einzelwellen Dichtungssatz 02-102263
Erhältlich als Doppelwellen Dichtungssatz 02-102264
- Erhältlich als Rotationsbau gruppe 877422.
- Erhältlich als Lagersatz 877425
- ◇ Erhältlich bei Reglertyp C
- Siehe Montageanweisungen
- ⊞ Siehe Montagehinweis

* Non disponible séparément.

- ▲ Compris dans la pochette 02-102263 (joint d'arbre simple)
Pochette équivalente 02-102264 (joint d'arbre double)
- Compris dans le kit d'ensemble rotatif 877422.
- Compris dans le kit de roulement 877425.
- ◇ Omis sur le sous-ensemble de commande C.
- Voir la remarque sur le sens de rotation.
- ⊞ Voir la remarque sur le montage.

* Non in vendita singolarmente

- ▲ Disponibile nella serie a singola guarnizione d'albero 02-102263
Equivalente alla serie a doppia guarnizione 02-102264
- Disponibile nel kit per il gruppo rotante 877422
- Disponibile nel kit del cusci netto 877425
- ◇ Omettere sul controllo C S/A
- Vedere istruzioni per il montaggio
- ⊞ Vedere nota per il montaggio

Item	Torque values
Pos.	Anziehmomente
Rep.	Couples de serrage
Pos.	Coppia di serraggio
1	31-37 Nm. (23-28 lb.ft.)
2a	8-10 Nm. (6-7.3 lb.ft.)
2b	97-106 Nm. (71-78 lb.ft.)
2h	75-83 Nm. (55-60 lb.ft.)
2o	29-32 Nm. (21-24 lb.ft.)
2q	29-32 Nm. (21-24 lb.ft.)
3	83-102 Nm. (61-75 lb.ft.)
4	83-102 Nm. (61-75 lb.ft.)
5	83-102 Nm. (61-75 lb.ft.)
6a	12.7-13Nm. (8.9-9.5 lb.ft.)
6j	75-83 Nm. (55-60 lb.ft.)
6m	75-83 Nm. (55-60 lb.ft.)
10a	31-37 Nm. (23-27 lb.ft.)
13	97-106 Nm. (71-78 lb.ft.)
15	7-9 Nm. (5-6.6 lb.ft.)
19	3.6-4.4 Nm. (2.3-3 lb.ft.)
25	75-83 Nm. (55-60 lb.ft.)

All repairs must be made in clean conditions and by clean practices compatible with subsequent efficient operations of the unit in systems having filtration to 25µm or finer.

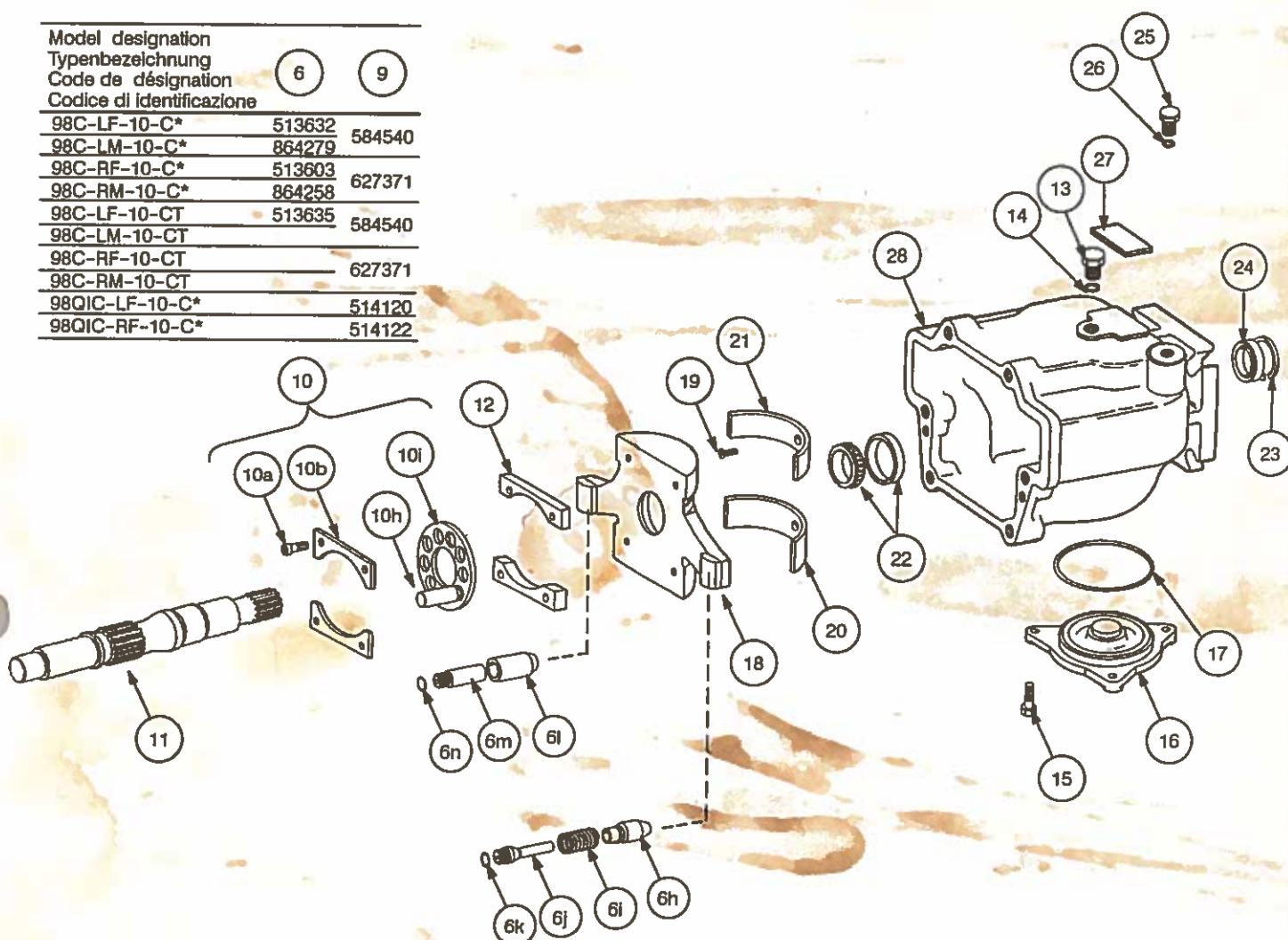
Bei Inbetriebnahme und Betrieb dieser Präzisionsgeräte ist die Filterung der Druckflüssigkeit - auf 25 µm oder feiner - Voraussetzung für optimale Wirtschaftlichkeit und Lebensdauer.

Toutes les réparations doivent être faites dans des conditions saines et par des moyens propres compatibles avec le fonctionnement correct de l'appareil dans un circuit filtré à 25 microns ou mieux.

Le riparazioni devono essere effettuate in ambiente pulito e in ogni caso in condizioni tali da consentire un regolare funzionamento in sistemi idraulici con grado di filtrazione di 25 o più fine.

Model designation Typenbezeichnung Code de désignation Codice di identificazione	2	2f	2m	2q	2r	Pressure range Druckbereich Plage de tarage Pressione di taratura
98C-**-10-C	02-125160	857681	-----	627391	154128	70-250 Bar
98C-**-10-CM	02-125162	857675	-----	627391	154128	35-140 Bar
98C-**-10-CV	02-125161	857681	857688	627391 (2)	154128 (2)	70-280 Bar

Model designation Typenbezeichnung Code de désignation Codice di identificazione	6	9
98C-LF-10-C*	513632	584540
98C-LM-10-C*	864279	
98C-RF-10-C*	513603	627371
98C-RM-10-C*	864258	
98C-LF-10-CT	513635	584540
98C-LM-10-CT		
98C-RF-10-CT		627371
98C-RM-10-CT		
98QIC-LF-10-C*	514120	
98QIC-RF-10-C*	514122	



NOTE

Use shims (item 8) as required to obtain 0.01-0.10 mm (.0004-.004 in.) axial shaft endplay.

HINWEIS

Erfordliche Anzahl Scheiben Pos. Nr. 8 für ein axiales Wellenspiel von 0.01-0.10 mm (.0004-.004 in.) verwenden.

REMARQUE

Monter les cales d'épaisseur (rep. 8) nécessaires pour que l'arbre ait un jeu axial de 0,01 à 0,10 mm (0,0004-0,004 in.).

NOTA

Usare spessori (particolare 8) necessari per realizzare un gioco assiale all'estremità dell'albero di 0.01-0.10 mm.

NOTE

Right hand rotation shown. For left hand rotation install control rod (6m) & control piston (6l) in valve block port #2 & bias rod (6j), bias piston (6h), & spring (6i) in valve block port #1.

HINWEIS

Dargestellt für Rechtslauf. Für Linkslauf Steuerstange (6m) & Steuerkolben (6l) in Ventilblock Anschluß #2 und Haltestange (6j), Haltekolben (6h) & (6i) in Ventilblock Anschluß #1 montieren.

REMARQUE

Rotation à droite: modèle illustré. Rotation à gauche: dans le bloc de distribution, monter d'une part la tige (6m) et le piston (6l) de commande dans l'orifice n° 2, et d'autre part la tige (6j) et le piston (6h) de maintien ainsi que le ressort (6i) dans l'orifice n° 1.

NOTA

Viene illustrata la rotazione destra. Per la rotazione a sinistra installare l'asta di controllo (6m) e il pistone di controllo (6l) nell'attacco del blocco valvola n.2; l'asta di reazione (6j), il pistone di reazione (6h) e la molla (6i) nell'attacco del blocco valvola n.1.



VICKERS

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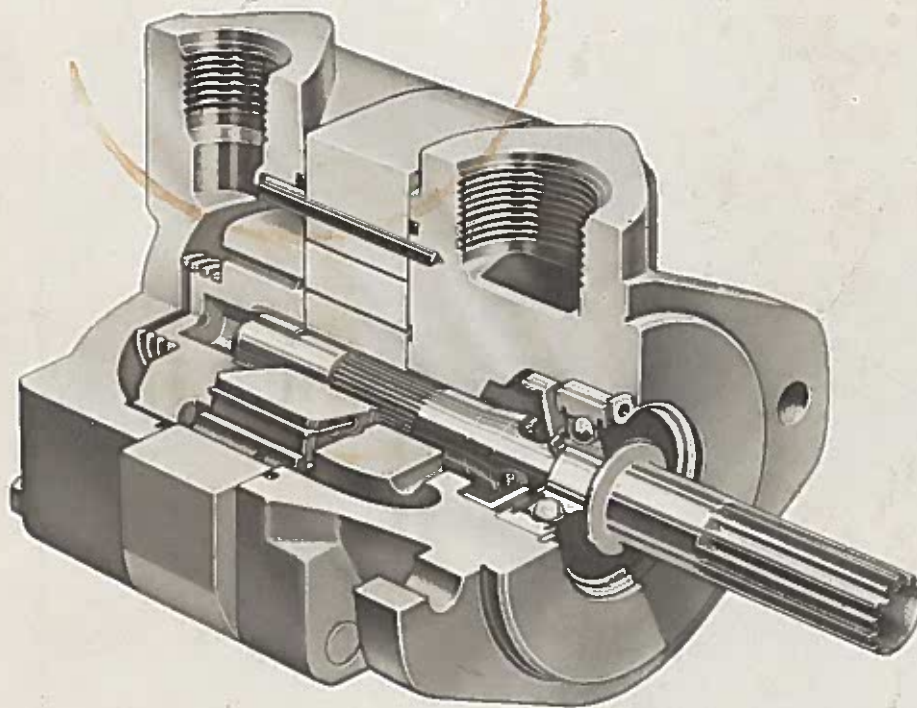


Overhaul Manual

Vane
Pumps

V10, V20, V10F, V10P,
V20F, V20P Series

*TECHNICAL
DATA*



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

Revised 12-1-87

I-3143-S

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A. PURPOSE OF MANUAL

This manual has been prepared to assist the users of Vickers balanced vane type hydraulic single pumps in properly installing, maintaining and repairing their units. In the sections which follow, the single pumps are described in detail, their theory of operation is discussed and instructions are given for their proper installation, maintenance and overhaul.

The general series of models covered are V10, V20, V10F, V10P, V20F, and V20P. The information given applies to the latest design configurations listed in Table 1. Earlier designs are covered only insofar as they are similar to the present equipment.

B. GENERAL INFORMATION

1. Related Publications - Service parts information and installation dimensions are not contained in this manual. The parts catalogs and installation drawings listed in Table 1 are available from any Vickers

Application Engineering office, or from:

Vickers, Incorporated
1401 Crooks Road
Troy, MI 48064

2. Model Codes - There are many variations within each basic model series, which are covered by variables in the model code. Table 2 is a complete breakdown of the code covering these units. Service inquiries should always include the complete unit model number, which is stamped on the pump cover.

TABLE 1.
PARTS CATALOGS AND INSTALLATION DRAWINGS

MODEL SERIES	PARTS DRAWING	INSTALLATION DRAWING
V10	M-2005-S	MB-53
V10F		
V10P		
V20	M-2004-S	MB-53
V20F		
V20P		
HYDRAULIC OIL RECOMMEN- DATIONS	INDUSTRIAL APPLICATIONS	MOBILE APPLICATIONS
	I-286-S	M-2950-S

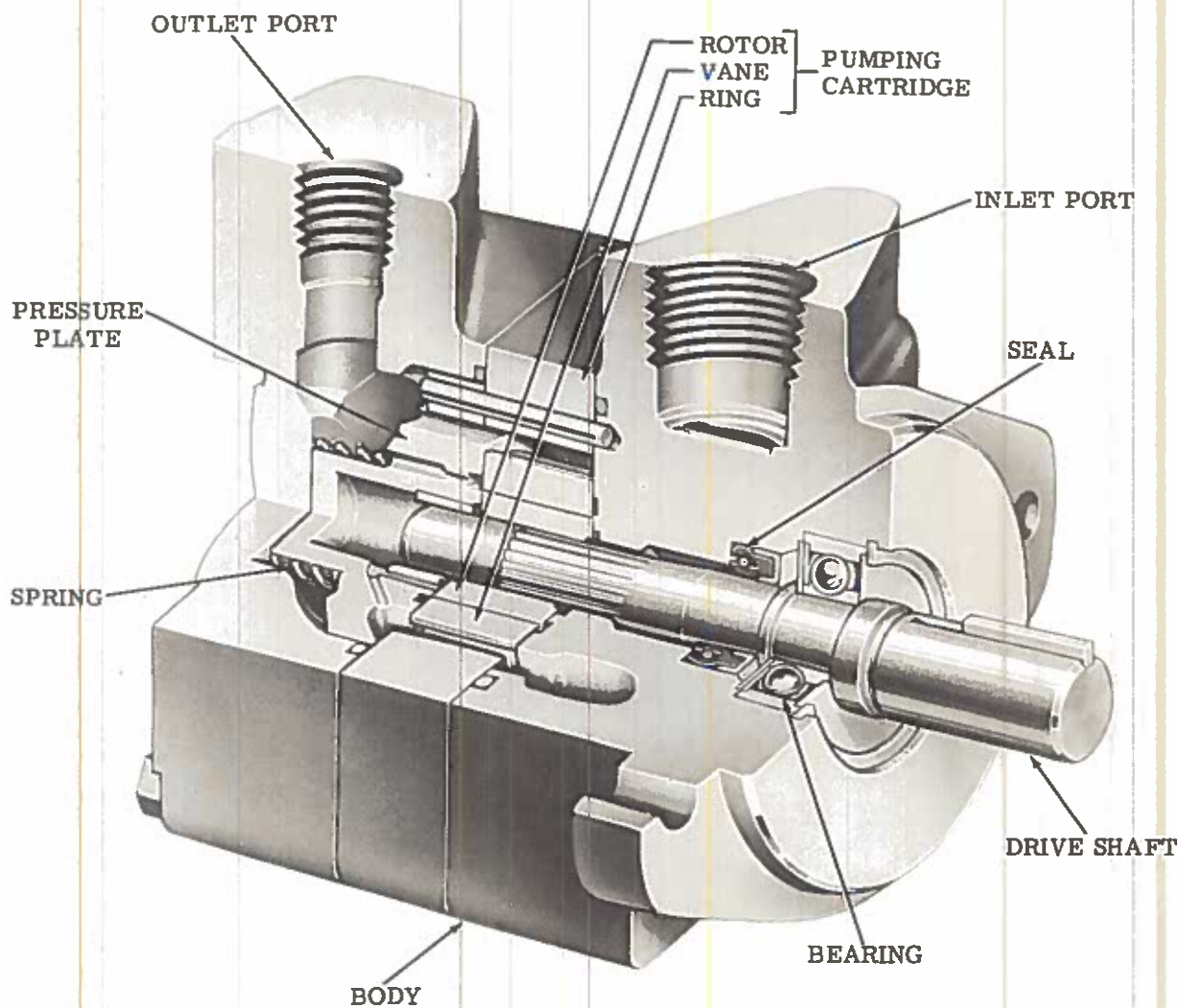


Figure 1

MODEL CODE BREAKDOWN

V10-(P) * * * * - * * (*)-(*) 20- * * * * L

VANE PUMP

SERIES
10 OR 20

F - FLOW CONTROL COVER
P - PRIORITY VALVE COVER
OMITTED - STD. COVER

MOUNTING

1-2 BOLT FLANGE (SAE "A" SIZE)
2-FOOT BRACKET AT 12 O'CLOCK
(VIEWED FROM THE SHAFT END)
23-FOOT BRACKET AT 3 O'CLOCK
26-FOOT BRACKET AT 6 O'CLOCK
29-FOOT BRACKET AT 9 O'CLOCK

INLET PORT		
CODE	MODEL	SIZE
E	V20	1.5"Dia. -2 BOLT FLG.
F		1.156"Dia. -2 BOLT FLG.
H	V10	1" O.D. TUBE CONN.
K		1.3125"-12 UN2B THD.
P	V20	1" N.P.T.F.
R		1.25" N.P.T.F.
S	V10	1.3125"-12 STR. THD.
	V20	1.625"-12 UN2B THD.
T	V10	1.1875"-12 STR. THD.

RING CAPACITY -1200 RPM-100PSI
(V10) (V20)

1 - 1 USGPM	6 - 6 USGPM
2 - 2 USGPM	7 - 7 USGPM
3 - 3 USGPM	8 - 8 USGPM
4 - 4 USGPM	9 - 9 USGPM
5 - 5 USGPM	11 - 11 USGPM
6 - 6 USGPM	12 - 12 USGPM
7 - 7 USGPM	13 - 13 USGPM

FOR LEFT HAND ROTATION
VIEWED FROM SHAFT END

SPECIAL FEATURE SUFFIX

DESIGN & MODIFICATION
V10-10 V20(F)-11
V10(F)-20 V20P-11/12

PRESSURE SETTING
A-250 PSI
B-500 PSI
C-750 PSI
D-1000 PSI
E-1250 PSI
F-1500 PSI
G-1750 PSI
H-2000 PSI
J-2250 PSI
K-2500 PSI

FLOW RATE THROUGH
ORIFICE IN COVER
2-2 GPM
3-3 GPM (V10F ONLY)
4-4 GPM
5-5 GPM (V10F ONLY)
6-6 GPM
7-7 GPM (V10F ONLY)
8-8 GPM (V20F ONLY)

PRESSURE PORT POSITIONS
VIEW FROM COVER END
A-OPPOSITE INLET
CONNECTION.
B- 90° COUNTERCLOCKWISE
FROM INLET CONNECTION
C-INLINE WITH INLET
D-90° CLOCKWISE FROM INLET
CONNECTION

SHAFTS

1-STR. KEYED
3-THD.
4-THD.
6-STR. STUB-KEYED
11-SPLINE-9 TOOTH
12-SPLINE-13 TOOTH
15-SPLINE-13 TOOTH
27-TANG
34-THD.
38-SPLINE-11 TOOTH

		OUTLET PORT CONNECTIONS				
		FLOW CONTROL COVER		PRIORITY VALVE COVER		
CODE	STANDARD COVER	PRESSURE	TANK	PRIMARY OUTLET	SECONDARY OUTLET	TANK
K	—	—	—	9/16-18 ST. THD. (V10P)	3/4-16 ST. THD. (V10P)	9/16-18 ST. THD. (V10P)
P	1/2 IN. NPT THD. (V10 ONLY)	3/4-16 ST. THD.	1/2 IN. NPT THD.	—	—	—
	3/4 IN. NPT THD. (V20 ONLY)	V10F AND V20F	V10F AND V20F	—	—	—
S	3/4-16 ST. THD.	—	—	—	—	—
	1 1/16-12 ST. THD. (V20 ONLY)	3/4-16 ST. THD. (V20F)	1 1/16-12 ST. THD. (V20F)	—	—	—
T	—	3/4-16 ST. THD. (V10F)	3/4-16 ST. THD. (V10F)	3/4-16 ST. THD. (V20P)	7/8-14 ST. THD. (V20P)	3/4-16 ST. THD. (V20P)

Section II - DESCRIPTION

A. GENERAL

Pumps in this series are used to develop hydraulic fluid flow for the operation of Mobile and Industrial equipment. The positive displacement pumping cartridges are the rotary vane type with shaft side loads hydraulically balanced. The flow rate depends on the pump size and the speed at which it is driven.

All units are designed so that the direction of rotation, pumping capacity and port positions can be readily changed to suit particular applications.

B. ASSEMBLY AND CONSTRUCTION

The V10 series pump illustrated in the cut-a-way of Figure 1 is representative of all single pumps in this series. The unit consists principally of a ported body, a ported cover and a pumping cartridge. Components of the pumping cartridge are an elliptical cam ring, a slotted rotor splined to fit the drive shaft and twelve vanes fitted to the rotor slots.

The pumping cartridge cam ring is sandwiched between the body and cover. A ball bearing and bushing located in the body and pressure plate respectively support each end of the drive shaft and center the rotor within the cam ring. As the drive shaft is driven by the prime mover, the rotor and vanes generate flow by carrying fluid around the elliptical cam ring contour. Fluid enters the cartridge through the inlet port in the body and is discharged through the pressure plate into the outlet port of the cover.

Section III - PRINCIPLES of OPERATION

A. PUMPING CARTRIDGE

As mentioned in Section II, fluid flow is developed by the pumping cartridge. The action of the cartridge is illustrated in Figure 2. The rotor is driven within the cam ring by the driveshaft, which is coupled to a power source. As the rotor turns, centrifugal force causes the vanes to follow the elliptical inner surface of the cam ring.

C. FLOW CONTROL AND RELIEF VALVE

V10 and V20 pumps are available with an integral Flow Control and Relief Valve in the pump cover. This limits the fluid flow in the system to a maximum prescribed rate and prevents excessive pressure build-up. Fluid not required in the system is recirculated to tank.

D. PRIORITY VALVE

V10 and V20 pumps are also available with a priority valve located in the pump cover. The priority valve maintains nearly a constant flow to a primary circuit and diverts the remaining flow to a secondary circuit. Flow going to the secondary circuit is determined by pump delivery. The primary circuit is protected by an integral relief valve but an external relief valve must be provided for the secondary circuit.

E. APPLICATION

Pump ratings in GPM as shown in the model coding are at 1200 RPM and 100 PSI. For ratings at other speeds, methods of installation and other application information, Vickers Application Engineering personnel should be consulted.

Radial movement of the vanes and turning of the rotor cause the chamber volume between the vanes to increase as the vanes pass the inlet sections of the cam ring. This results in a low pressure condition which allows atmospheric pressure to force fluid into the chambers. (Fluid outside the inlet is at atmospheric pressure or higher.)

This fluid is trapped between the vanes and carried

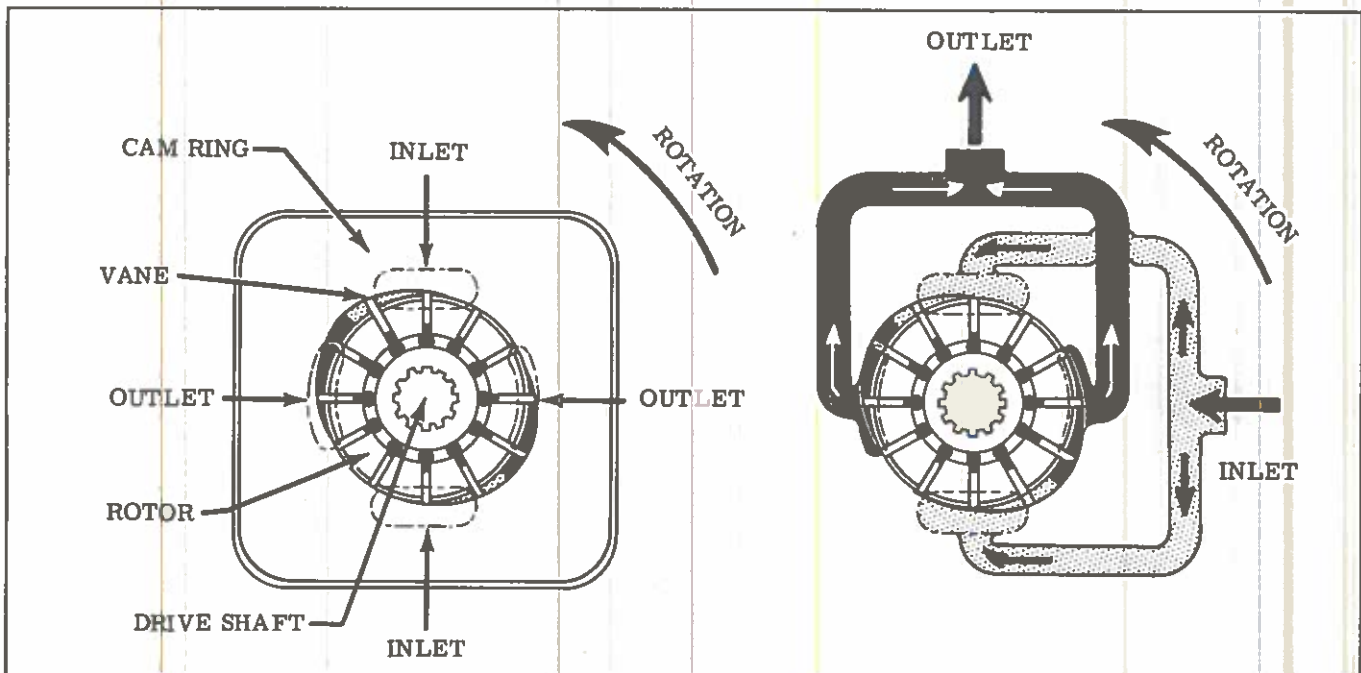


Figure 2

past the large diameter or dwell section of the cam ring. As the outlet section is approached, the cam ring diameter decreases and the fluid is forced out into the system. System pressure is fed under the vanes, assuring their sealing contact against the cam ring during normal operation.

B. HYDRAULIC BALANCE

The pump cam ring is shaped so that the two pumping chambers are formed diametrically opposed. Thus, hydraulic forces which would impose side loads on the shaft are cancelled.

C. PRESSURE PLATE

The pressure plate seals the pumping chamber as shown in Figure 3. A light spring holds the plate against the cartridge until pressure builds up in the system. System pressure is effective against the area at the back of the plate, which is larger than the area exposed to the pumping cartridge. Thus, an unbalanced force holds the plate against the cartridge, sealing the cartridge and providing the proper running clearance for the rotor and vanes.

D. FLOW CONTROL AND RELIEF VALVE

1. Maximum flow to the operating circuit and maximum system pressure are determined by the integral flow control and relief valve in a special outlet cover used on some V10 and V20 pumps. This feature is illustrated pictorially in Figure 4. An orifice in the cover limits maximum flow. A pilot-operated type relief valve shifts to divert excess fluid delivery to tank, thus limiting the system pressure to a predetermined maximum.

2. Figure 4A shows the condition when the total pump delivery can be passed through the orifice.

This condition usually occurs only at low drive speeds. The large spring chamber is connected to the pressure port through an orifice. Pressure plus spring load in this chamber slightly exceeds pressure at the

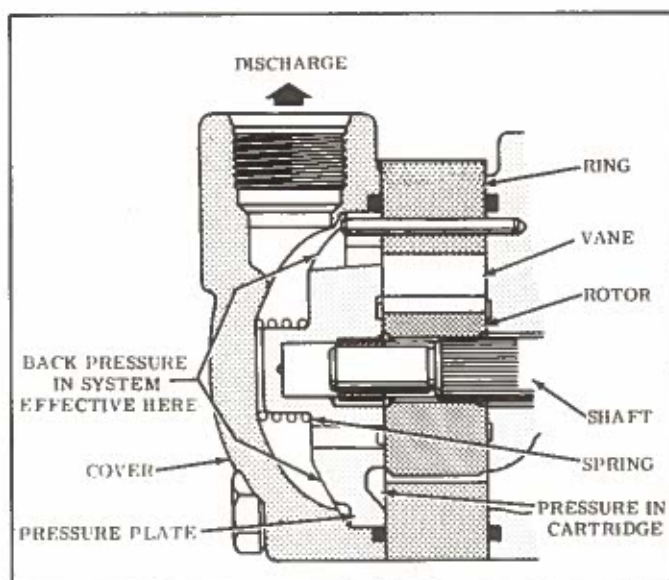


Figure 3

other end of the relief valve spool and the spool remains closed. Pump delivery is blocked from the tank port by the spool land.

3. When pump delivery is more than the flow rate determined by the orifice plug, pressure builds up across the orifice and forces the spool open against the light spring. Excess fluid is throttled past the spool to the tank port as shown in Figure 4B.

4. If pressure in the system builds up to the relief valve setting (Figure 4C), the pilot poppet is forced off its seat. Fluid in the large spring chamber flows through the spool and out to tank. This flow through the small sensing orifice, causes a pressure drop and prevents pressure in the large spring area from increasing beyond the relief valve setting. As pressure against the right end of the spool starts to exceed the relief valve setting, the pressure differential forces the spool to the left, against the light spring, porting the full pump flow to tank.

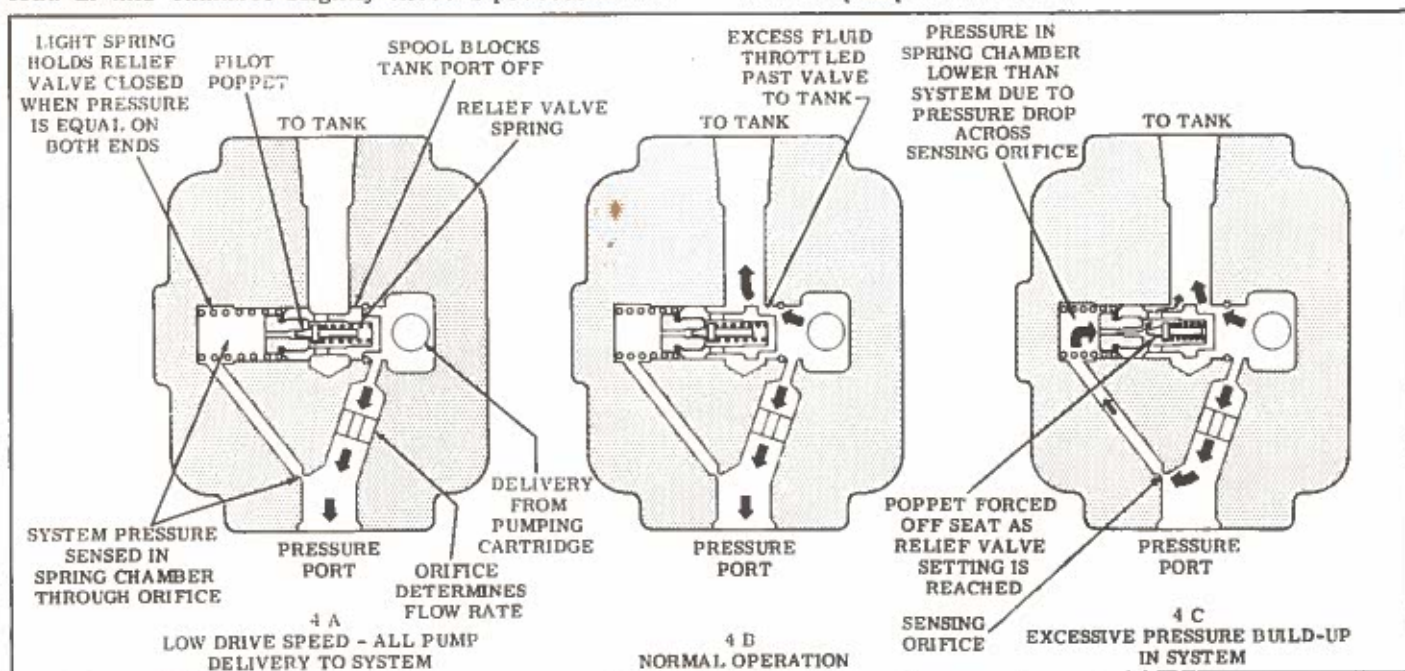


Figure 4

E. PRIORITY VALVE OPERATION

Referring to the V20P Cover Schematic, Figure 5, pressure is sensed in cavities "A", "B" and "C". Primary flow into cavity "A" is restricted by the controlled flow orifice "O". Secondary flow will be zero until the pump flow rate through orifice "O" develops a pressure differential across the control spool.

When pump delivery is increased, pressure builds up in cavities "B" and "C" because of the resistance to flow through orifice "O". This causes the spool to shift toward cavity "A" against the spring. The amount of spool shift is proportional to the pressure differential between cavities "A" and "C".

Flow from the primary port is held to an almost constant volume, as determined by orifice "O", and the metering action of the control spool at area "D". Flow to the secondary port varies with pump delivery. Metering area "E" diverts excess flow to the secondary port.

This single spool design cannot give precisely controlled flow to the primary circuit because of the effects of varying conditions of flows and pressures. For example: If the primary circuit is operating at 1000 PSI and the secondary at 100 PSI, the spool must be metering at "E". However, if primary pressure is 100 PSI and secondary is 1000 PSI, the spool must

be metering at "D". As the two systems approach the same pressure, the probability of flow fluctuation increases because the spool may shift between these two metering points.

CAUTION

The pump has a built-in relief valve in the primary circuit. However, an external relief valve must be provided for the secondary circuit to protect the pump.

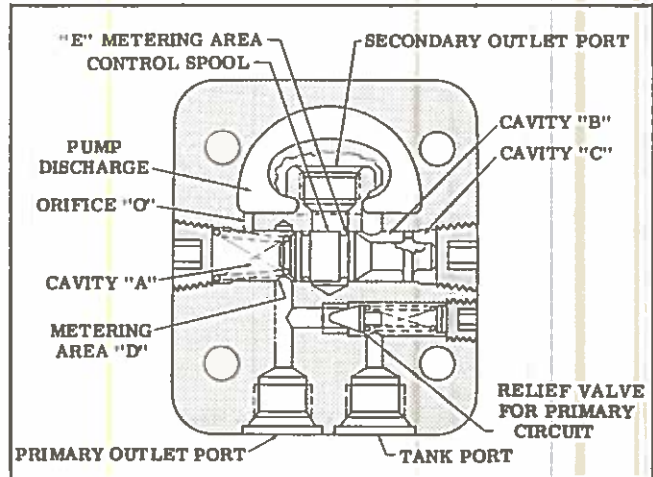


Figure 5

Section IV INSTALLATION and OPERATING INSTRUCTIONS

A. INSTALLATION DRAWINGS

The installation drawings listed in Table 1 show the correct installation dimensions and port locations.

B. DRIVE CONNECTIONS

CAUTION

Pump shafts are designed to be installed in couplings, pulleys, etc., with a slip fit or very light tap. Pounding can injure the bearings. Shaft tolerances are shown on the pump installation drawings. (See Table 1.)

1. Direct Mounting - A pilot on the pump mounting flange (Figure 6) assures correct mounting and shaft alignment. Make sure the pilot is firmly seated in the accessory pad of the power source. Care should

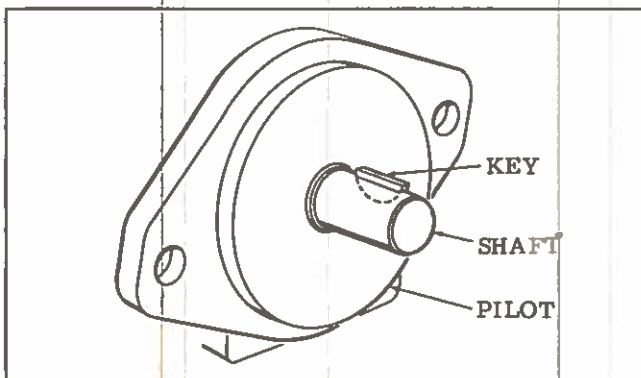


Figure 6

be exercised in tightening the mounting screws to prevent misalignment.

If gaskets are used, they should be installed carefully and should lay flat. Shaft keys and couplings must be properly seated to avoid slipping and possible shearing.

2. Indirect Drive - Chain, spur gear or v-belt pulley drives may also be used with these pumps. Flat belt drives are not recommended because of the possibility of slipping.

To prevent excessive side loads on pump bearings, it is important to check for correct alignment and guard against excessive belt or chain tension.

For best results on indirect drive applications, use the largest permissible pulley diameter at the pump and position it close as possible to the pump mounting face. For specific indirect drive application data, contact your Vickers Application Engineer.

C. SHAFT ROTATION

Pumps are normally assembled for right-hand (clockwise) rotation as viewed from the shaft end. A pump made for left-hand rotation is identified by an "L" in the model code (See Table 2).

NOTE

These pumps must be driven in the direction of the arrows cast on the pump ring. If it is desired to change the direction of drive rotation, it is necessary to reverse the ring. (See Section VI-B-D and Figure 10.)

CAUTION

Never drive a pump in the wrong direction of rotation. Seizure may result, necessitating expensive repairs.

D. PIPING AND TUBING

1. All pipes and tubing must be thoroughly cleaned before installation. Recommended methods of cleaning are sand blasting, wire brushing and pickling.

NOTE

For instructions on pickling refer to instruction sheet 1221-S.

2. To minimize flow resistance and the possibility of leakage, only as many fittings and connections as are necessary for proper installation should be used.

3. The number of bends in tubing should be kept to a minimum to prevent excessive turbulence and friction of oil flow. Tubing must not be bent too sharply. The recommended radius for bends is three times the inside diameter of the tube.

E. HYDRAULIC FLUID RECOMMENDATIONS

GENERAL DATA

Oil in a hydraulic system performs the dual function of lubrication and transmission of power. It constitutes a vital factor in a hydraulic system, and careful selection of it should be made with the assistance of a reputable supplier. Proper selection of oil assures satisfactory life and operation of system components with particular emphasis on hydraulic pumps. Any oil selected for use with pumps is acceptable for use with valves or motors.

Data sheets for oil selection are available from Vickers, Inc. Technical Publications, Troy, MI. 48084.

For Industrial Applications order data sheet I-286-S. For Mobile Applications order M-2950-S.

The oil recommendations noted in the data sheets are based on our experience in industry as a hydraulic component manufacturer.

Where special considerations indicate a need to depart from the recommended oils or operating conditions, see your Vickers representative.

CLEANLINESS

Thorough precautions should always be observed to insure the hydraulic system is clean:

A. Clean (flush) entire new system to remove paint, metal chips, welding shot, etc.

B. Filter each change of oil to prevent introduction of contaminants into the system.

C. Provide continuous oil filtration to remove sludge and products of wear and corrosion generated during the life of the system.

D. Provide continuous protection of system from entry of airborne contamination, by sealing the system and/or by proper filtration of the air.

E. During usage, proper oil filling and servicing of filters, breathers, reservoirs, etc., cannot be over emphasized.

F. Thorough precautions should be taken, by proper system and reservoir design, to insure that aeration of the oil will be kept to a minimum.

SOUND LEVEL

Noise is only indirectly affected by the fluid selection, but the condition of the fluid is of paramount importance in obtaining optimum reduction of system sound levels.

Some of the major factors affecting the fluid conditions that cause the loudest noises in a hydraulic system are:

1. Very high viscosities at start-up temperatures can cause pump noises due to cavitation.

2. Running with a moderately high viscosity fluid will impede the release of entrained air. The fluid will not be completely purged of such air in the time it remains in the reservoir before recycling through the system.

3. Aerated fluid can be caused by ingestion of air through the pipe joints of inlet lines, high velocity discharge lines, cylinder rod packings, or by fluid discharging above the fluid level in the reservoir. Air in the fluid causes a noise similar to cavitation.

4. Contaminated fluids can cause excessive wear of internal pump parts which may result in increased sound levels.

F. OVERLOAD PROTECTION

A relief valve must be installed in the system, unless it is an integral part of the pump. The relief valve limits pressure in the system to a prescribed maximum and protects the components from excessive pressure. The setting of the relief valve depends on the work requirements of the system components.

G. PORT POSITIONS

The pump cover can be assembled in four positions with respect to the body. A letter in the model

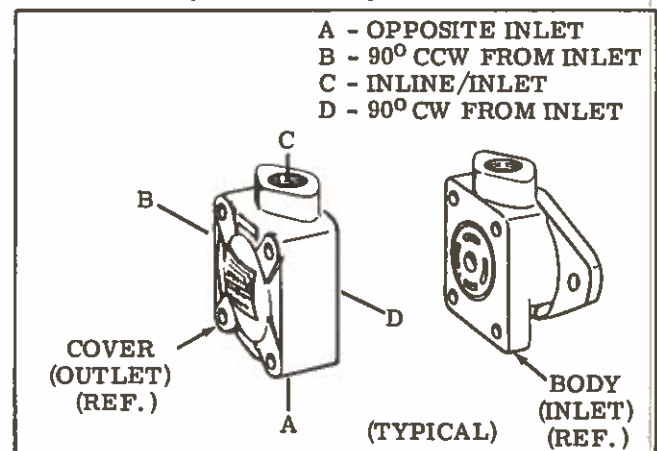


Figure 7

code (Table 2) identifies the cover position as shown in Figure 7.

Disassembly and assembly procedures are in Section VI-B and D.

H. START-UP

With a minimum drive speed of 600 RPM, a pump

should prime almost immediately, if provision is made to initially purge the air from the system. Failure to prime within a reasonable length of time may result in damage due to lack of lubrication. Inlet lines must be tight and free from air leaks. However, it may be necessary to crack a fitting on the outlet side of the pump to purge entrapped air.

Section V SERVICE, INSPECTION AND MAINTENANCE

A. SERVICE TOOLS

No special tools are required to service these pumps.

B. INSPECTION

Periodic inspection of the fluid condition and tube or piping connections can save time-consuming breakdowns and unnecessary parts replacement. The following should be checked regularly.

1. All hydraulic connections must be kept tight. A loose connection in a pressure line will permit the fluid to leak out. If the fluid level becomes so low as to uncover the inlet pipe opening in the reservoir, extensive damage to the pump can result. In suction or return lines, loose connections permit air to be drawn into the system, resulting in noisy and/or erratic operation.

2. Clean fluid is the best insurance for long service life. Therefore, the reservoir should be checked periodically for dirt or other contaminants.

If the fluid becomes contaminated the system should be thoroughly drained and the reservoir cleaned before new fluid is added.

3. Filter elements also should be checked and replaced periodically. A clogged filter element results in a higher pressure drop. This can force particles through the filter which would ordinarily be trapped, or can cause the by-pass to open, resulting in a partial or complete loss of filtration.

4. A pump which is running excessively hot or noisy is a potential failure. Should a pump become noisy or overheated, the machine should be shut down immediately and the cause of improper operation corrected.

C. ADDING FLUID TO THE SYSTEM

When hydraulic fluid is added to replenish the system, it should always be poured through a fine wire screen (200 mesh or finer).

It is important that the fluid be clean and free of any substance which could cause improper operation or wear of the pump or other hydraulic units. Therefore, the use of cloth to strain the fluid should be avoided to prevent lint getting into the system.

D. ADJUSTMENTS

No periodic adjustments are required, other than to maintain proper shaft alignment with the driving medium.

E. LUBRICATION

Internal lubrication is provided by the fluid in the system. Lubrication of the shaft couplings should be as specified by their manufacturers.

F. REPLACEMENT PARTS

Reliable operation throughout the specified operating range is assured only if genuine Vickers parts are used. Sophisticated design processes and material are used in the manufacture of our parts. Substitutions may result in early failure. Part numbers are shown in the parts catalogs listed in Table 1.

G. TROUBLE-SHOOTING

Table 3 lists the common difficulties experienced with vane pumps and hydraulic systems. It also indicates the probable causes and remedies for each of the troubles listed.

It should always be remembered that many apparent pump failures are actually the failures of other parts of the system. The cause of improper operation is best diagnosed with adequate testing equipment and a thorough understanding of the complete hydraulic system.

Section VI - OVERHAUL

WARNING

Before breaking a circuit connection, make certain that power is off and system pressure has been released. Lower all vertical cylinders, discharge accumulators and block any load whose movement could generate pressure.

A. GENERAL

Plug all removed units and cap all lines to prevent the entry of dirt into the system. During disassembly, pay particular attention to identification of the parts, especially the cartridges, for correct assembly.

Pump bearings are pressed in the bodies or on the shafts and should not be removed unless defective. Figure 8 is an exploded view which shows the proper relationship of the parts for disassembly and assembly. Refer to Figure 1 and Figure 8 for the correct assembled relationship of the parts.

B. DISASSEMBLY

1. Disassembly of Basic Pump—See Figure 8. If a foot bracket is used, remove before dismantling the pump. Clamp the pump body in a vise (not too

TABLE 6 - TROUBLE SHOOTING CHART

TROUBLE	PROBABLE CAUSE	REMEDY
PUMP NOT DELIVERING FLUID	DRIVEN IN THE WRONG DIRECTION OF ROTATION	The drive direction must be changed immediately to prevent seizure. Figure 10 shows the correct ring position for each direction of rotation.
	COUPLING OR SHAFT SHEARED OR DISENGAGED	Disassemble the pump and check the shaft and cartridge for damage. (See Section VI.) Replace the necessary parts.
	FLUID INTAKE PIPE IN RESERVOIR RESTRICTED	Check all strainers and filters for dirt and sludge. Clean if necessary.
	FLUID VISCOSITY TOO HEAVY TO PICK UP PRIME	Completely drain the system. Add new filtered fluid of the proper viscosity.
	AIR LEAKS AT THE INTAKE. PUMP NOT PRIMING	Check the inlet connections to determine where air is being drawn in. Tighten any loose connections. See that the fluid in the reservoir is above the intake pipe opening. Check the minimum drive speed which may be too slow to prime the pump.
	RELIEF VALVE STUCK OPEN. (MODELS WITH INTEGRAL RELIEF VALVE ONLY)	Disassemble the pump and wash the valve in clean solvent. Return the valve to its bore and check for any stickiness. A gritty feeling on the valve periphery can be polished with crocus cloth. Do not remove excess material, round off the edges of the lands or attempt to polish the bore. Wash all parts and reassemble the pump.
	VANE(S) STUCK IN THE ROTOR SLOT(S)	Disassemble the pump. Check for dirt or metal chips. Clean the parts thoroughly and replace any damaged pieces. If necessary flush the system and refill it with clean fluid.
INSUFFICIENT PRESSURE BUILD-UP	SYSTEM RELIEF VALVE SET TOO LOW	Use a pressure gage to correctly adjust the relief valve.
	COMPLETE LOSS OF FLOW FROM PUMP.	-A valve is stuck open permitting free flow to tank. -Broken inlet or pressure line. -Actuator bypassing the full flow. (Motor valve plate lift)
PUMP MAKING NOISE	PUMP INTAKE PARTIALLY BLOCKED	Service the intake strainers. Check the fluid condition and, if necessary, drain and flush the system. Refill with clean fluid.
	AIR LEAKS AT THE INTAKE OR SHAFT SEAL. (OIL IN RESERVOIR WOULD PROBABLY BE FOAMY)	Check the inlet connections and seal to determine where air is being drawn in. Tighten any loose connections and replace the seal if necessary. See that the fluid in the reservoir is above the intake pipe opening.
	PUMP DRIVE SPEED TOO SLOW OR TOO FAST	Operate the pump at the recommended speed.
	COUPLING MISALIGNMENT	Check if the shaft seal bearing or other parts have been damaged. Replace any damaged parts. Realign the coupled shafts.

tightly), cover end up, and remove the four cover screws. Note the position of the cover port with respect to the body port before lifting off the cover and "O" ring. (See paragraph 2 for disassembly of flow control covers and paragraph 3 for disassembly of the priority valve covers).

Remove the pressure plate and spring. Note the position of the ring for correct reassembly. Lift off the ring and remove the locating pins. Separate the vanes from the rotor and remove the rotor from the shaft.

Turn the pump body over then remove the shaft key and the snap ring which retains the bearing. Tap with a soft hammer on the splined end of the shaft to force the shaft out of the body. Remove the small snap ring, located on the shaft, behind the bearing. Support the bearing inner race and press the shaft out of the bearing. Pull the shaft seal out of the body with a suitable hooked tool.

CAUTION

Do not disassemble the relief valve S/A removed in the following step. The unit is factory set and could malfunction if disassembled.

2. Disassembly of Flow Control and Relief Valve Covers - See Figure 8. Remove the plug (and "O" ring latest design V10 models) from the snap ring side of the cover. Then remove the plug (and "O" ring latest design V10 models), that releases the spring and relief valve S/A. Insert a suitable tool from the snap ring end of the bore. Slide the relief valve S/A from the cover. Remove the snap ring with care - DO NOT scratch the bore.

3. Disassembly of the Priority Valve Cover - See Figure 8. Remove the plug (and "O" ring latest design V10/V20 models) and spring from one end of the priority valve bore, and the plug (and "O" ring latest design V10/V20 models) from the other end of the bore. Insert a suitable tool into the snap ring end of the bore (Snap ring used with pipe thread plugs only) and slide the priority valve spool from the cover. If the snap ring exists, remove it from the cover. Disassemble the relief valve by removing the plug spring poppet and shims. On later designs, a spring guide is used. See Figure 8. DO NOT remove the seat unless inspection of the poppet contact area reveals a problem in the seat area. If removal of the seat is required, thread the seat with a suitable tap approximately 3/8 inch into the seat. Thread a long bolt into the seat and pull the bolt and seat from the bore with a small gear puller.

C. INSPECTION AND REPAIR

CLEANING. All parts must be thoroughly cleaned and kept clean during inspection and assembly. The close tolerance of the parts makes this requirement more stringent than usual. Clean all removed parts, using a commercial solvent that is compatible with the system fluid. Compressed air may be used in cleaning, but it must be filtered to remove water and contamination. Clean compressed air is particularly useful in cleaning spools, orifices, and cover passages.

1. Discard the used shaft seal and all "O" rings. Wash the metal parts in a solvent, blow them dry with filtered compressed air and place them on a clean surface for inspection.

2. Check the wearing surfaces of the body, pressure plate, ring and rotor for scoring and excessive

wear. Remove light score marks by lapping. Replace any heavily scored or badly worn parts.

3. Inspect the vanes for burrs, wear and excessive play in the rotor slots. Replace the vanes and rotor if the slots are worn.

4. Check the bearings for wear and looseness. Rotate the bearings while applying pressure to check for pitted or cracked races.

5. Inspect the oil seal mating surface on the shaft for scoring or wear. If marks on the shaft cannot be removed by light polishing, replace the shaft.

6. Flow Control Cover: Check the relief valve sub-assembly for free movement in the cover bore. Remove burrs from the valve by polishing, but DO NOT round off the corners of the lands. Do not attempt to rework the valve bore. If the bore is damaged, replace the cover.

7. Priority Valve Cover: Inspect the priority valve spool and bore for burrs. Remove burrs from the spool by light polishing with crocus or # 500 grit paper. DO NOT round off sharp corners of the lands. Inspect the cover bore for scratches, wear and/or a pitted surface. DO NOT attempt to rework the bore. If the bore is damaged, replace the cover. The priority valve spool must fit and move within the bore without evidence of bind. Rotate the spool through 360° while inspecting for bind. Inspect the snap ring for damage. (V20 units only). If worn or bent, replace with a new snap ring. If the snap ring is bent, inspect the snap ring groove in the cover for sufficient depth and rounded edges of the snap ring groove. If the groove is defective, replace the cover.

Integral Relief Valve: Inspect the spring. The spring ends must be parallel to prevent cocking of the poppet. The poppet requires a close inspection in the seat contact area. A slight wear pattern should exist around the poppet at the area of seat contact. If the wear pattern is broken, a possible leakage path exists between the poppet and seat. Inspect the seat for possible erosion or other defects. Refer to the seat removal procedure if the seat is defective. (Paragraph VI. B. 3)

D. ASSEMBLY

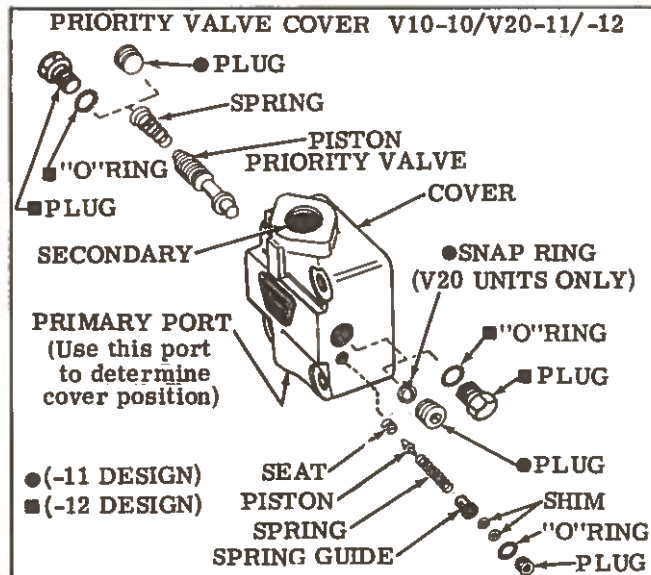
Coat all parts with hydraulic fluid to facilitate assembly and provide initial lubrication. Use small amounts of petroleum jelly to hold "O" rings in place during assembly.

IMPORTANT

During handling and shipping of the precision machined cartridge parts, it is possible to raise burrs on the sharp edges. All sharp edges on the parts of a new cartridge kit should be stoned prior to installation.

1. Assembly of Flow Control Cover - See Figure 8. Assemble the snap ring in place within the bore, (early design only) seat firmly in the groove. Insert the valve in the bore, small land first. Then install the spring and both plugs. Use new "O" rings if straight thread plugs are used.

2. Assembly of priority valve cover - See Figure 8. If the relief valve seat was removed, a new seat must be pressed into the body. Lubricate and insert the new seat chamfered end first into the cover open-



NOTE: Priority Cover Information:
 V10-10 early models and V20-11 models use pipe threaded plugs.
 V10-10 current design and V20-12 models use straight threaded plugs and "O"ring seals.

Flow Control Cover Information:
 V10-20 early models and V20-11 models use pipe threaded plugs.
 V10-20 current design uses straight threaded plugs with "O"rings. The V20-11 is the current design and still uses pipe threaded plugs.

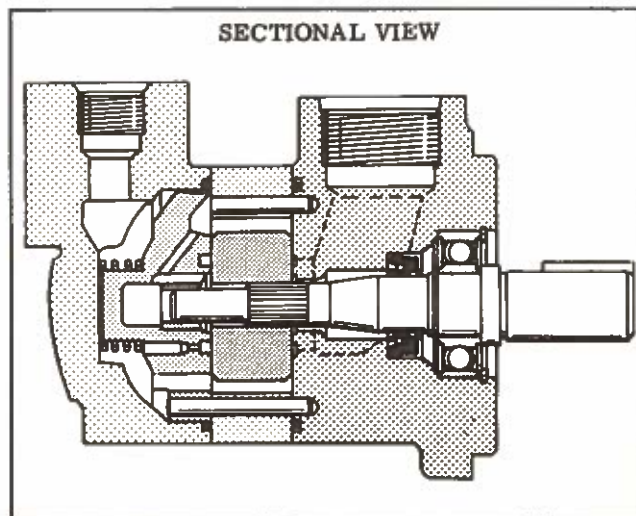
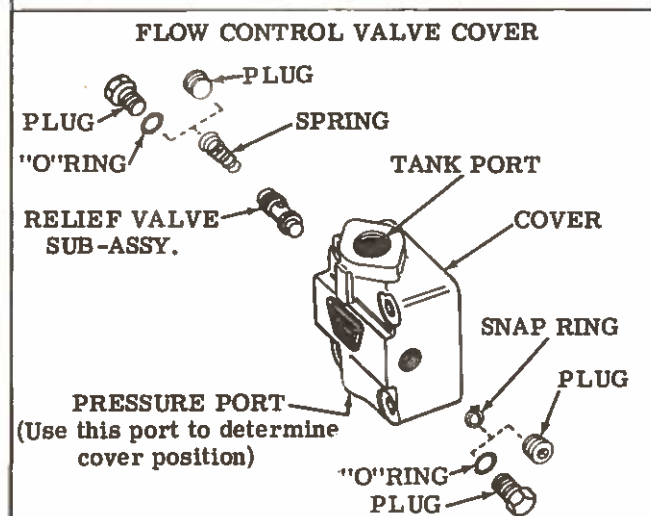
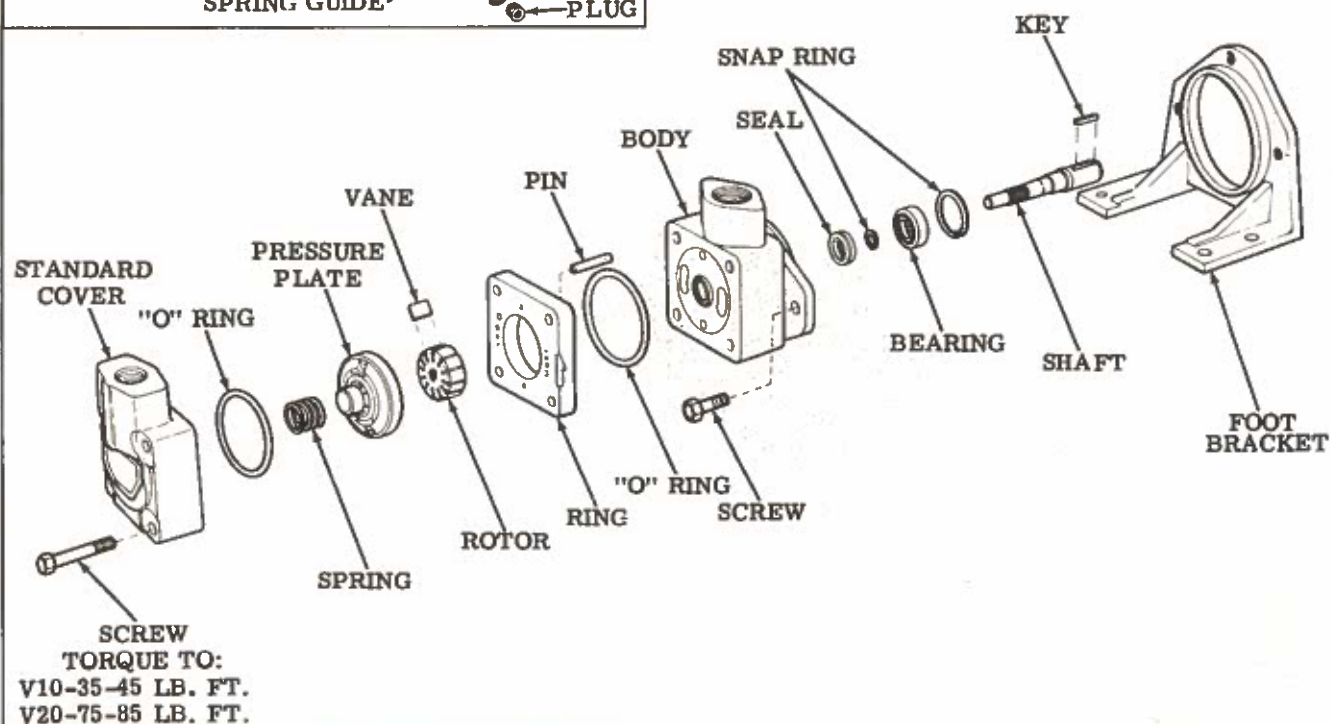


Figure 8

ing. Align square and press into place. Use a short length of brass rod as a pressing tool, to prevent seat damage. Clean the relief valve bore to remove chips and filings. Insert the poppet into the bore, align square and lightly tap the stem of the poppet to mate the poppet and seat. Install the spring, shims, and plug into the cover. (later design uses a spring guide and straight thread plug with "O"rings) Be sure to check the pressure setting of the relief valve against the model code. If the setting is out of tolerance, readjust by removing or adding shims. (Removing shims reduces pressure while adding shims increases pressure.)

Priority Valve - Install the snap ring within the priority valve cover bore, (early V20 series only); make sure the snap ring is seated within its groove. Insert the priority valve spool, small land first, into the bore. Install plugs at each end of the bore and secure. Refer to Figure 8 for spool orientation.

3. Assembly of Pump - See Figure 8. Begin assembly by pressing the shaft into the front bearing while supporting the bearing inner race. Install the small snap ring on the shaft.

NOTE

Before assembling the shaft seal, determine the cor-

Section VII - TESTING

If a test stand is available, the pump should be tested at the recommended speeds and pressures shown on the installation drawing. (See Table 1).

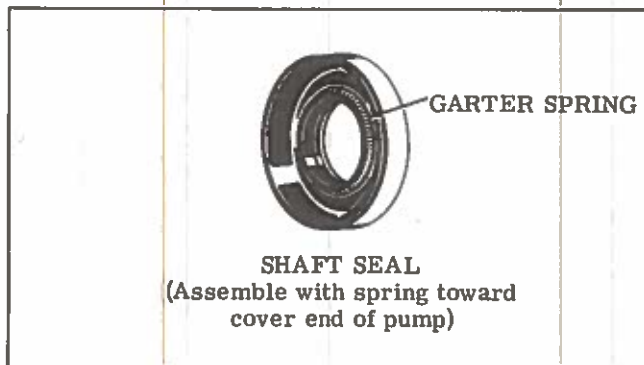


Figure 9

rect position of the sealing lip. (See Figure 9.) Seals are assembled with the garter spring toward the pumping cartridge. Press the seal firmly in place and lubricate the lip with petroleum jelly or other grease compatible with the system fluid. Slide the drive shaft into the body until the bearing is seated. Tap lightly on the end of the shaft if necessary. Install the snap ring.

Install new "O" rings in the body and cover. Insert the ring locating pins in the body and assemble the ring so that the arrow on the perimeter points in the direction of rotation. Check the assembly against Figure 10. Install the rotor on the shaft and insert the vanes in the rotor slots. Be certain the radius edges of the vanes are toward the cam ring.

Place the pressure plate on the locating pins and flat against the ring. Place the spring over the pressure plate, and then install the cover with the outlet port in the correct position. Tighten the cover screws to the torque shown in Figure 8. Rotate the shaft by hand to insure that there is no internal binding. Install the shaft key.

If a foot mounting is used, assemble the pump to its foot mounting. If a gasket is used, be certain it is flat to avoid misalignment of the shaft.

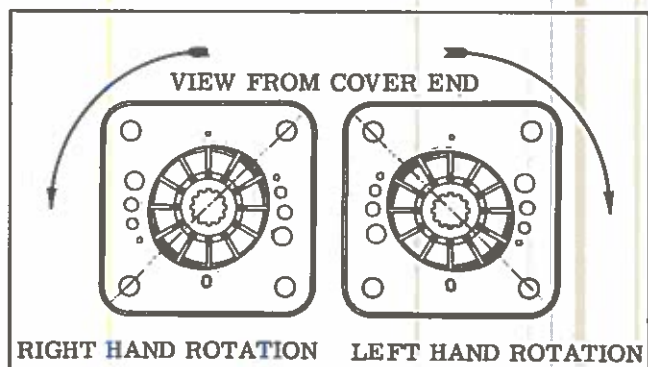
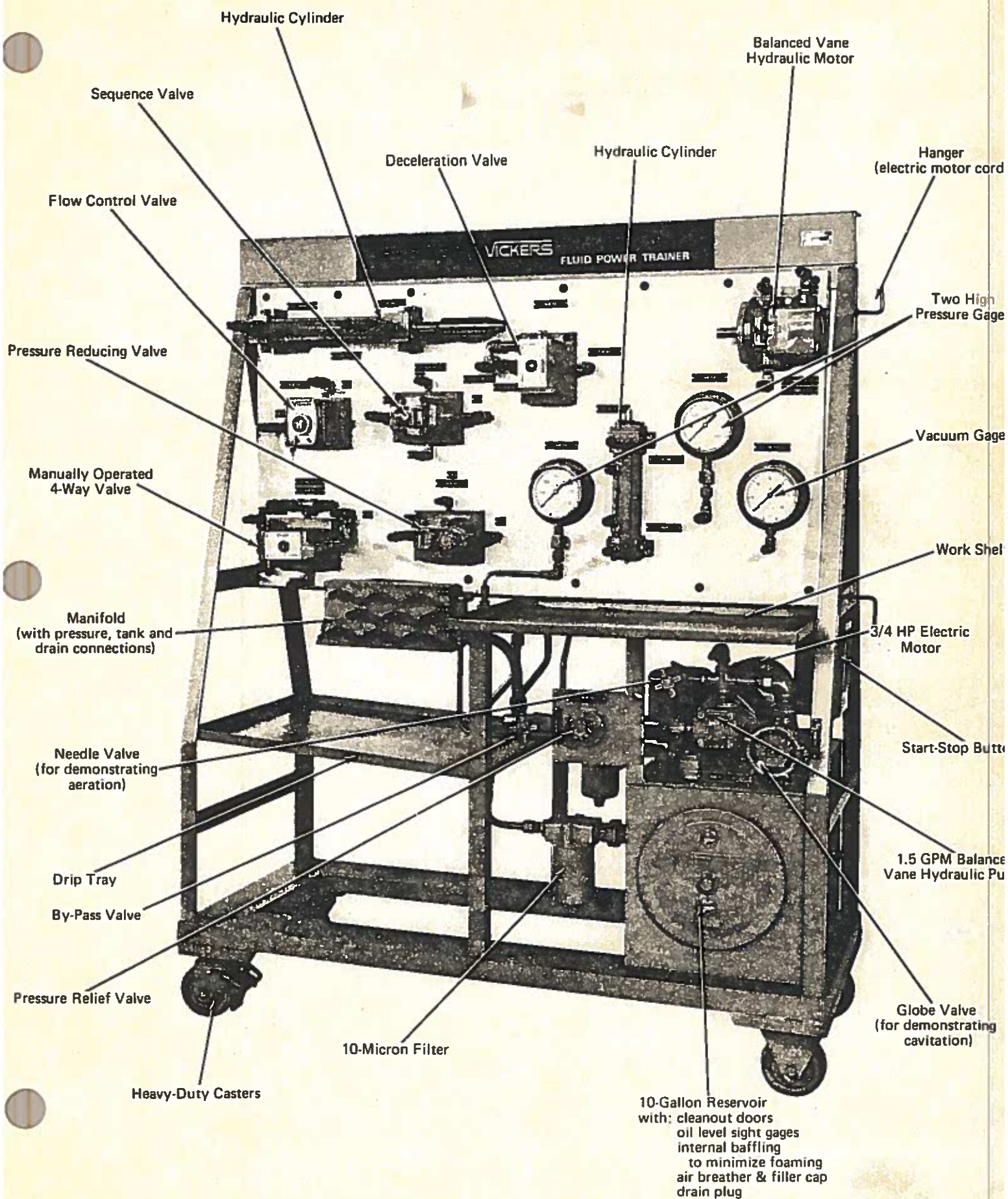


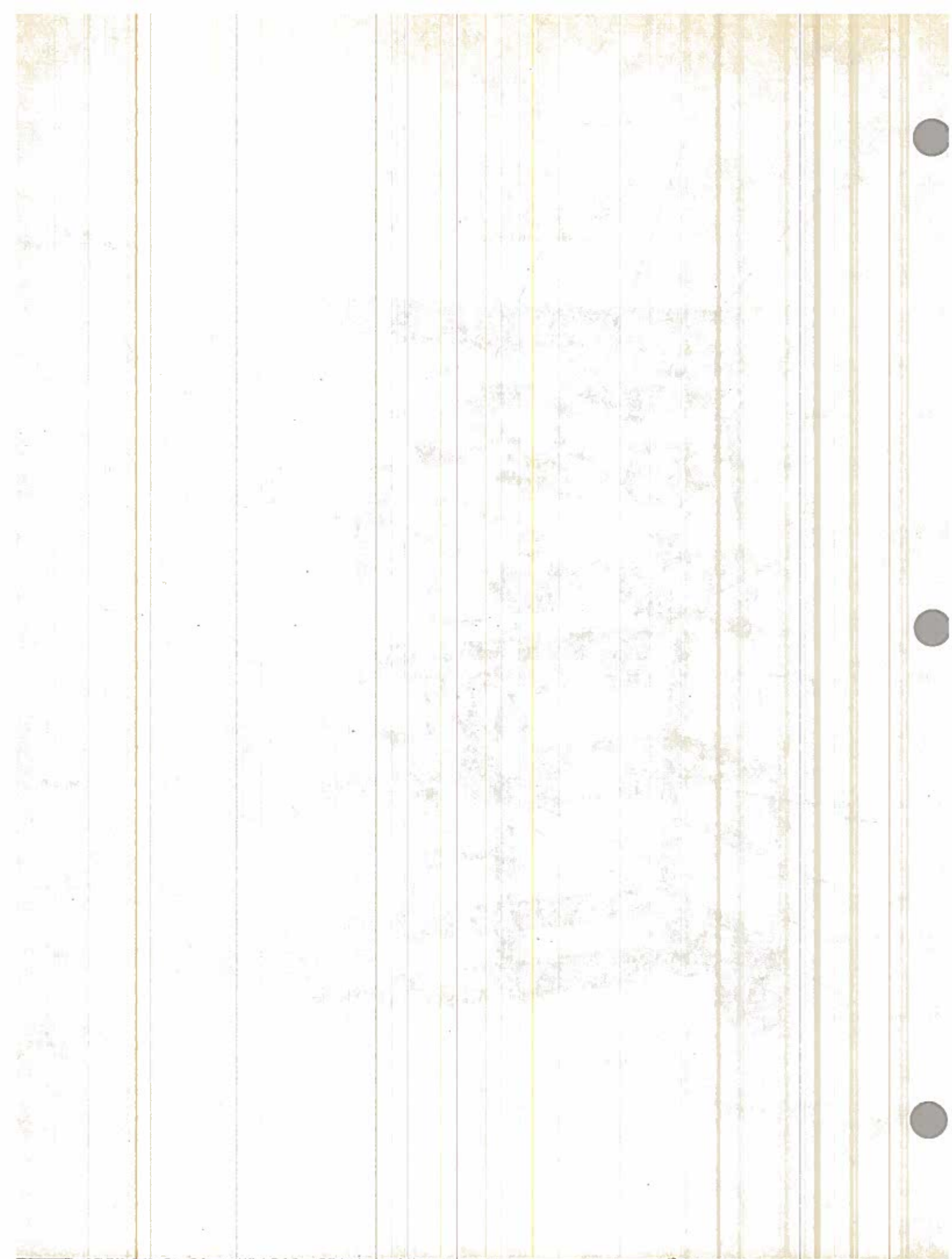
Figure 10



Litho in U.S.A

VICKERS





INTRODUCTION TO THE HYDRAULIC TRAINER

NOTE: After completing the project, keep this work sheet with your other training materials as reference.

I. INTRODUCTION

The Hydraulic Trainer can be used to demonstrate many of the principles and circuits which have been discussed in the lectures. All of the components are the standard units as used on industrial applications.

A part of the trainer circuit is rigidly plumbed. This portion consists of the reservoir, pump, filters, restriction valve, bypass valve, aeration valve, and relief valve.

Hoses with quick-disconnect fittings make it easy to connect the other components into a circuit. Both the hoses and the fittings on the components contain check valves to prevent excessive oil spillage.

Although the hydraulic components are capable of operation at higher pressures, we limit the maximum operating pressure to 500 psi to prevent overloads on the electric motor. After familiarization, you are to check this maximum pressure.

II. FAMILIARIZATION

Identify the function and model number (if available) of the rigidly plumbed components shown in Figure 1.

Write the description in the spaces provided. Be as explicit as possible. For example:

NEEDLE VALVE

Opens pump inlet to atmosphere
to demonstrate aeration

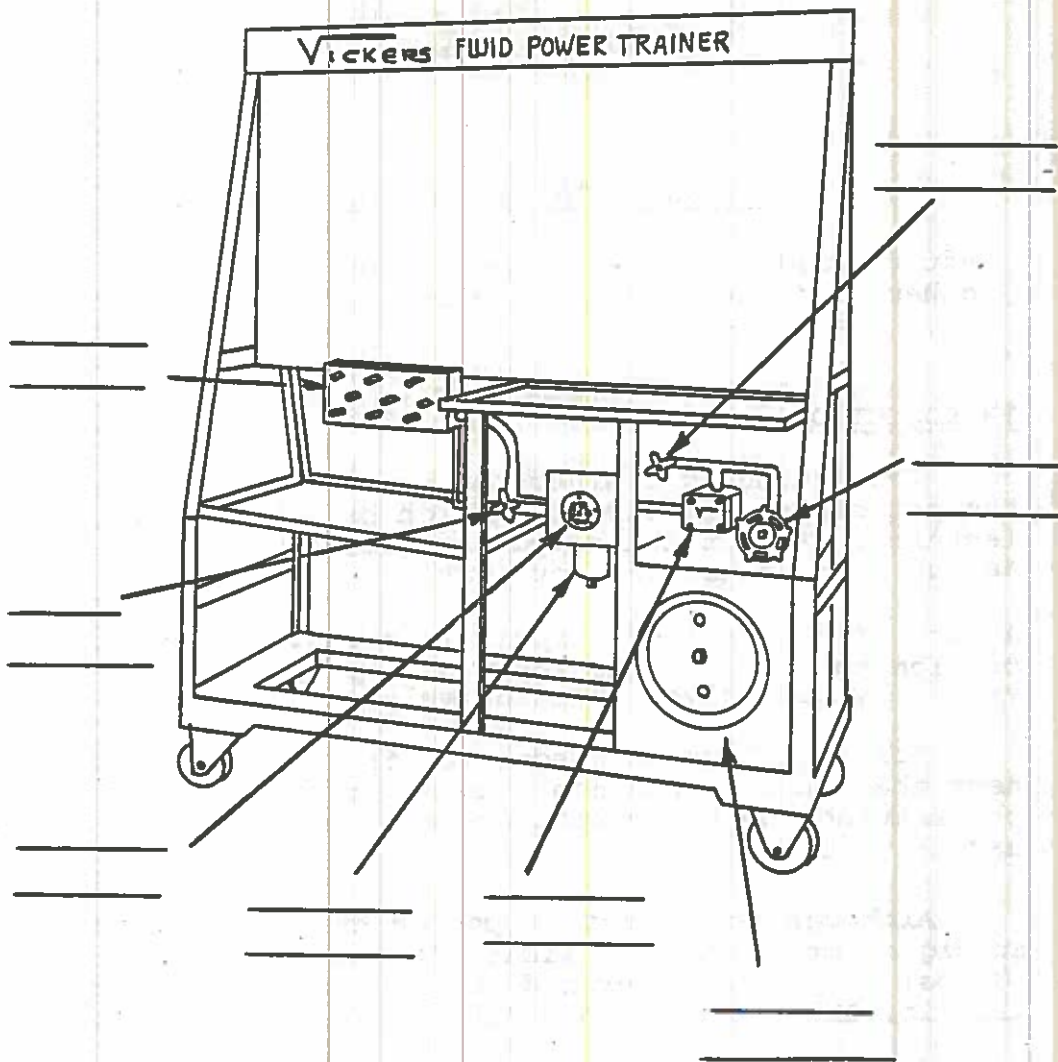


FIGURE 1. IDENTIFICATION OF COMPONENTS

III. CHECKING MAXIMUM PRESSURE

- A. Open the tank bypass valve.
- B. Identify the pressure gauge that is used to indicate system pressure.
- C. Plug the power cord into the 115 A.C. wall outlet and start the electric motor.
- D. Slowly close the bypass valve while observing the pressure gauge. Do not allow the pressure to exceed 500 psi. If it tends to be greater or is less, loosen the lock nut and adjust the relief valve until the pressure is 500 psi when the bypass is fully closed. Tighten the lock nut after the adjustment is made.
- E. Shut off the electric motor.

IV. RECIPROCATING CYLINDER WITH OPERATION AT TWO DIFFERENT MAXIMUM PRESSURES

- A. Complete the drawing shown in Figure 2. The purpose of the circuit is to reciprocate the vertical cylinder with the directional valve. In addition, the maximum pressure on the cap end is to be 200 PSI. The maximum pressure at the rod end is to be 500 PSI.
- B. Now connect the circuit on the trainer as you have drawn it. Extend the cylinder and adjust the pressure reducing valve to limit the pressure at the cap end to 200 psi. Retract the cylinder and observe the pressure reading on the other gauge.

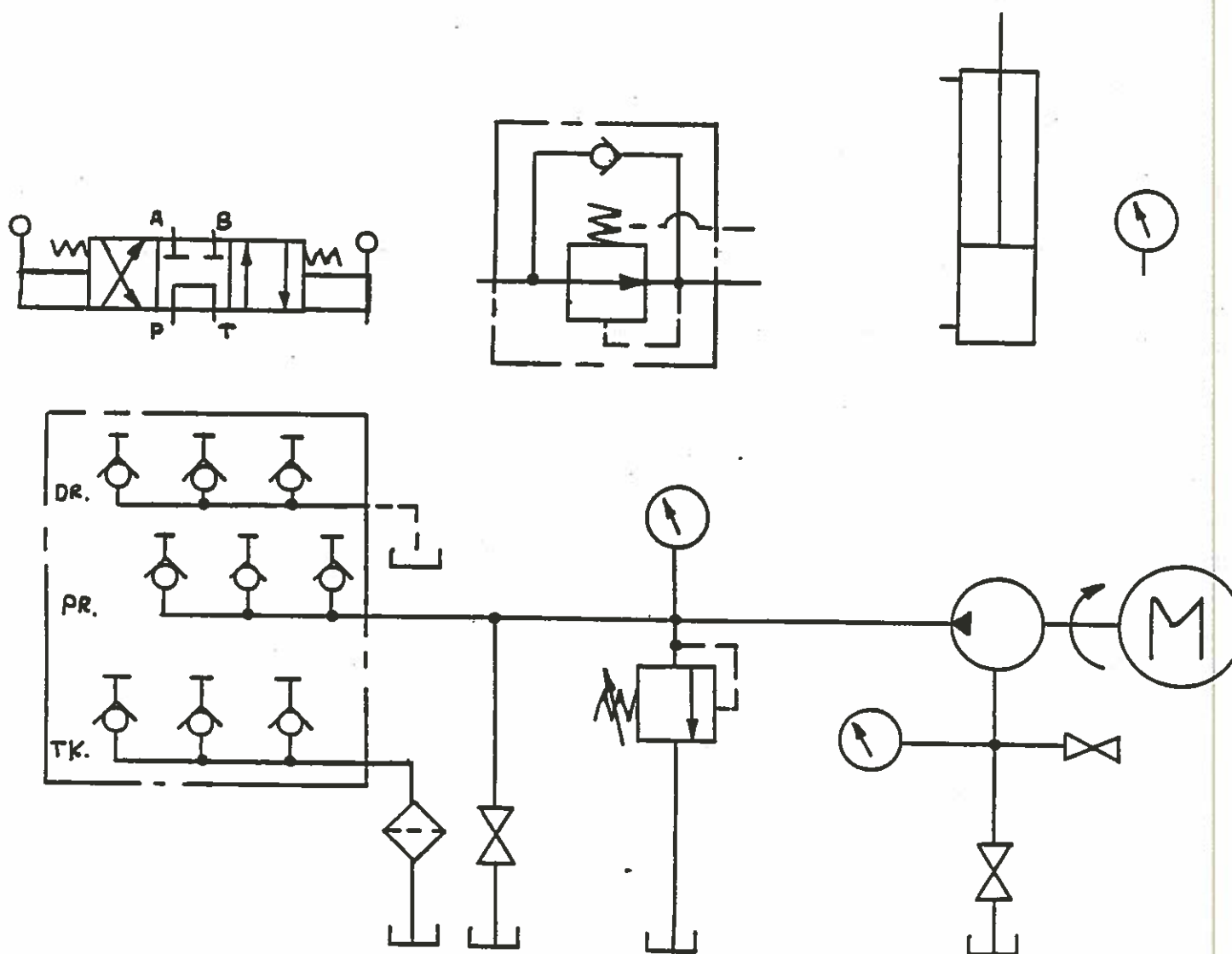


FIGURE 2. RECIPROCATING CIRCUIT

IV. QUESTIONS

- (A) What is the minimum reduced pressure we can obtain at cap end of the cylinder in this circuit?
_____ PSI

What determines this pressure? _____

- (B) What is the maximum recommended setting of the reducing valve in this application with relief valve set at 500 PSI? _____ PSI

- (C) With the Trainer operating and 200 PSI at the cap of the cylinder, remove the drain connection at the manifold. What happens? Why? _____

GENERAL HYDRAULIC HINTS

GOOD ASSEMBLY PRACTICES

1. Most important – cleanliness.
2. All openings in the reservoir should be sealed after cleaning.
3. No grinding or welding operations should be done in the area where hydraulic components are being installed.
4. All cylinder, valve, pump and hose connections should be sealed and/or capped until just prior to use.
5. Mineral spirits should be kept in safety containers.
6. Air hoses can be used to clean fittings and other system components. However, the air supply must be filtered and dry to prevent contamination of the parts.
7. Examine pipe fittings and hose assemblies prior to use to be certain that burrs, dirt and/or scale are not present.
8. All pipe and tubing ends should be reamed to prevent restriction and turbulent flow.
9. Do not use teflon tape or compound on pipe thread or straight thread connections.
10. When installing pumps or motors, always align coupling halves as closely as possible, within 0.007 inch.
11. When using flexible couplings, follow the manufacturer's recommendations or allow 1/32 to 1/16 inch clearance between the coupling halves.
12. Do not drive couplings on pump or motor shafts. They should be a slip fit, or shrunk on using hot oil.
13. Always use a dry spray-on lubricant on splines when installing. This prevents wear and adds to the life of the splines.
14. When using double universal joint couplings, the shafts must be parallel and the yokes must be in line.
15. When installing V-belt pullys on pumps or motors, line up both pulleys as closely as possible. Always install the pulleys with a minimum amount of overhang as close to the pump or motor face as possible. This increases bearing service life.

PIPES

Iron and steel pipes were the first kinds of plumbing used to conduct fluid between system components. At present, pipe is the least expensive way to go when assembling a system. Seamless steel pipe is recommended for use in hydraulic systems with the pipe interior free of rust, scale and dirt.

Early classifications of pipe wall thicknesses were: standard, extra heavy and double extra heavy. Today, pipes are classified by schedule number as specified by the American National Standards Institute (ANSI). The schedule numbers vary from 10 through 160. The larger the number, the heavier the wall thickness. The outer pipe diameter stays the same for a given pipe size while the inside opening becomes smaller as schedule number increases.

A comparison of early classifications verses the ANSI classifications follow.

Standard = schedule 40, extra heavy = schedule 80. The double extra heavy classification does not compare with a schedule number. However, the inside diameter of a double extra heavy pipe is approximately one half that of a schedule 160 pipe.

In many cases, flanges are welded to the pipe ends and gaskets or "O" rings used to seal the fittings. Various pipe fittings are used to route the piping too and from each system component. These fittings can be threaded or welded in place as the need arises. Threaded connections are used in low pressure applications where welded connections are used if high pressure, high temperature, or where a severe mechanical load exists.

All piping should be secured with clamps to prevent vibration and excessive stress due to the weight of the fluid. Do not weld the clamps to the pipe as it may weaken the pipe and cause a stress crack to appear.

TUBING DO'S AND DON'TS

1. Don't take heavy cuts on thin wall tubing with a tubing cutter. Use light cuts to prevent deformation of the tube end. If the tube end is out of round, a greater possibility of a poor connection exists.
2. Ream tubing to remove burrs only. DO NOT over ream tubing as it can weaken the connection.
3. Do not allow chips to accumulate in the tubing. They can be difficult to remove after bending.
4. Follow the manufacturers recommendations on the use of flaring tools. Don't over-tighten the feed screw handle on a compression type flaring tool. Improper use of a tool can cause washout and/or splitting of the flare connection.
5. Bend tubing instead of cutting and using a fitting. This reduces pressure drop and minimizes system losses. The minimum radius of a tubing bend should be at least three times the inside diameter of the tube. Larger bends are preferred.

6. Sketch the optimum tubing route before beginning the bending process. Be sure to use tubing with the proper temper to prevent wrinkles and flattened bends.

7. Most flares are made by hand or power tools that swage the tube end over a split die. The standard flare angle is 37° from the centerline. For best results, heavy wall tubing should be cut, deburred, flared and bent using power equipment.

An excellent catalog on sealing technology, or how to prevent leakage of hydraulic fluid, is available from Vickers. The catalog is aptly titled "Stop Leaks"

Subjects described in the catalog are: preventive maintenance, corrective maintenance, threaded fittings, tube fittings, hose and hose fittings, dynamic seals and static seals. Each subject is covered in detail to provide a user with the latest information available.

HINTS ON MAINTENANCE OF HYDRAULIC FLUID IN THE SYSTEM



Hydraulic Fluid Changes

Good maintenance procedures make it mandatory to keep the hydraulic fluid clean. A daily/weekly or monthly log should be kept on the hydraulic fluid condition.

No hard and fast rule can be established for changing the fluid because of the great variety of operating conditions. However, we do know that when filter elements are replaced frequently, service life of a system increases. Periodic testing of the fluid by the supplier is recommended to confirm suitability for continued use and to establish the correct fluid and filter element replacement interval.

Some of the considerations affecting hydraulic fluid life are: operating temperature, type of service, contamination levels, filtration, and the chemical composition of the fluid.

Fluid Recommendations

The basic recommendations for fluid are stipulated in Vickers bulletins I-286-S and M-2950-S. The fluids recommended by these bulletins give the assurance of adequate wear protection and excellent chemical stability under the most adverse operating conditions.

On mobile applications, the viscosity grade of the fluid should be changed in spring and autumn as is done with automobile engines. Hydrostatic transmissions and control mechanisms may require a different viscosity fluid. Fluid requirements are normally outlined in the original equipment manufacturers operation and maintenance manuals.

Draining The System

The system should be started and fluid heated before draining. This will lower the time it takes to drain the system and allow impurities suspended in the fluid to be removed. It is desirable to remove all fluid from the system. Bleeding of the fluid at the lowest point in the system will help in most cases.

Systems which have accumulated deposits that were not removed during draining must be flushed with a light viscosity fluid. The fluid should contain a rust inhibitor to protect metal surfaces against rust formation after draining.

When hydraulic fluid is added to replenish the system, it should be pumped through a 25 micron filter. If such a filter is not available, a funnel with a fine wire screen (200 mesh or finer) can be used. It is important that fluid be clean and free of all substances which will cause improper operation.

FLUID CONTAMINATION/AERATION—CAUSES AND EFFECTS

CONTAMINATION

A contaminated system can be the result of several factors: system design inadequate, poor maintenance of the system, poor housekeeping of the system and adverse operating conditions

A. System Design Inadequate

1. Reservoirs which cannot be cleaned.
2. Breathers that permit abrasives, inherent in the atmosphere to enter the system.
3. Poor cylinder packing design (no wiper to clean dirt from the piston rod).
4. Improper piston rod design (piston rods with poor wear characteristics).
5. Improper valving (anti-cavitation checks omitted from cylinder circuits with rapid drop characteristics).
6. Failure to provide adequate filtration.

B. Poor Maintenance of the System

1. Improper and unclean practices when adding fluid to the system.
2. Failure to clean breathers.
3. Failure to change pitted cylinder rods and worn cylinder packings.
4. Failure to use good cleanliness practices when changing system components.
5. Failure to change filter cartridges and/or fluid at proper intervals.
6. Failure to purge debris from the system after a pump failure.

C. Poor Housekeeping of the System

Surgical cleanliness is not required, however, ordinary clean practices during assembly will pay off in increased service life of the equipment.

Excessive and improper use of pipe thread sealer on lines and gaskets in the system can cause pump failures. This is especially true when a type of sealer is used that hardens.

Another source of contamination is fittings, hoses and lines which are received from a vendor uncapped. The use of brazed or welded fittings, and unpickled steel plating can also contribute to the contamination.

Vickers data sheet 1221-S covering the preparation of pipes, tubes and fittings should be referred to and followed. This will lower the possibility of premature failure due to contamination of the system.

D. Adverse Operating Conditions

From experience, we have found that machines used in a very dusty atmosphere and in windy areas require special components. For example, heavy duty breathers, chrome plated piston rods, plus frequent changes of the filter cartridges are also required.

Effects of Contamination

Contamination affects all types of hydraulic equipment adversely. Precision high tolerance parts are very susceptible to the effects of contamination. Dirty fluid causes wear which accelerates leakage and the development of heat in a system. Heat lowers the lubricity of a hydraulic fluid and causes additional wear.

If a hydraulic pump or motor should fail, the system becomes contaminated. Remove the unit for repair. The reservoir must be drained, flushed and cleaned. All hoses, lines, cylinders and valves should be inspected for wear and particles of the unit that failed. Flush all components of the complete system to remove metallic particles.

Replace filter elements. Dispose of the fluid removed from the system and fill the reservoir with clean hydraulic fluid. Install a new or rebuilt unit and start-up the system. Allow the system to run for a period of time to verify normal operation. Filter elements should be changed after 40 or 50 hours of operation. This guarantees that the system is essentially clean and free of any residue of the failed unit.

A very good reference catalog on contamination is available from Vickers called "Effective Contamination Control in Fluid Power Systems". This catalog describes types and sources of contamination, effects of types and sizes of particles, specifying contamination levels, selecting a filter, locating a filter, design steps and worked examples and fluid sampling and analysis.

AERATION (air bubbles in the fluid)

Causes

The following are candidates for the formation of air in a system.

- A. Leaking inlet lines.
- B. Control valve "O" rings leaking.
- C. Shaft seal leakage.
- D. Leaking cylinder packings caused by cavitating cylinders.
- E. Turbulence or sloshing in the reservoir.
- F. Vortexing fluid in the reservoir.
- G. Release of air suspended within the fluid.

Effects

Aeration can be in many forms: large bubbles, foam or in various degrees of suspension. It usually causes pump noise (cavitation). Small bubbles cause extreme and rapid ring wear, with corresponding vane tip wear. Larger bubbles cause vanes to collapse and pound. This pounding effect develops rippling in the ring and the ring will have a dull appearance. This is more apparent on straight vane rings which are hardened cast iron. With extreme aeration cases, the wear is so rapid that a ring and vanes can be destroyed within an hour. In many cases, a large step will be worn in the ring contour at the pressure quadrant. When the step reaches a depth where the vane extends and locks, the vane and/or ring will break. Also, the shaft can break where it enters the rotor if the torque is great enough.

Cures

A. Leaking Inlet Lines

1. Pipe threaded fittings can be porous. Use an approved type of pipe thread sealer on all pipe threads.
2. If the pump inlet flange surface is rough, scored or mutilated, air leakage past the "O" ring seal can result.

With any of the above defects, air can be pulled into the system.

B. Control Valve "O" Rings Leaking

"O" rings are used to seal against port leakage in many control valves. These seals can be checked by applying heavy grease around the part to be checked. If the noise stops, the trouble has been located and repair can be initiated.

On systems which have been operating at excessive high temperatures, the "O" rings can harden and take a set. If this occurs, air leakage can result. This is true not only in a pump, but also in the rest of the components of the system. Another factor enhancing air leakage is the actual fluid composition. Fluids which have a high sulphur content tend to accelerate "O" ring hardness. This is one of the principle reasons for keeping system operating temperatures down. Normal operating temperature of a system is 90° above ambient. When operating temperatures are in excess of this value, trouble may result. Maximum operating temperatures should be checked at the pump outlet port.

C. Shaft Seal Leakage

Most vane pumps are internally drained. The shaft seal cavity is connected to the pump inlet. Excessively high inlet vacuums can cause air leakage at the shaft seal. The maximum vacuum measured at the pump inlet should not exceed five inches of mercury.

Shaft misalignment can increase the probability of air leakage past the shaft seal. Universal jointed couplings or splined couplings can cause seal leakage if not properly aligned. Straight (direct) couplings should never be used.

The use of the wrong type of tools can cause distortion or mutilation of a shaft seal at installation. The outer diameter of the shaft should be lightly polished before installation to remove any burrs or roughness in the area of the shaft seal.

Shaft seals must be made of the correct material for a given application. A material that is not compatible with system fluid can deteriorate and result in a leakage problem.

D. Leaking Cylinder Packings Caused By Cavitating Cylinders

On applications where a rapid raise and lower cycle is experienced, air can enter the system through a cylinder rod seal. Vacuums in excess of 20 inches of mercury have been recorded in systems without anti-cavitation check valves. This is enough to force dirt particles past the shaft seal into the system with the air. An anti-cavitation check will allow flow from the reservoir to enter the rod area of the cylinder during a vacuum condition. Anti-cavitation checks should always be used to prevent a high vacuum condition from developing. This will lower the possibility of fluid contamination through the rod seal of a working cylinder.

E. Turbulence or Sloshing in the Reservoir

Return lines, if improperly located, can cause turbulence and aeration. A plexiglass window should be placed in the prototype reservoir to study flow conditions. Return lines emptying above the fluid level cause bubbles to form in the system. Return lines should always be terminated below the fluid level. Vehicle movement can cause sloshing within the reservoir. Reservoir must be deep enough to prevent aeration.

F. Vortexing Fluid in the Reservoir

If the fluid level in the reservoir is low and the inlet demand is great, a vortex condition can develop which pulls air into the pump inlet. In a hydraulic system, vortexing is normally the result of low fluid or poor reservoir design.

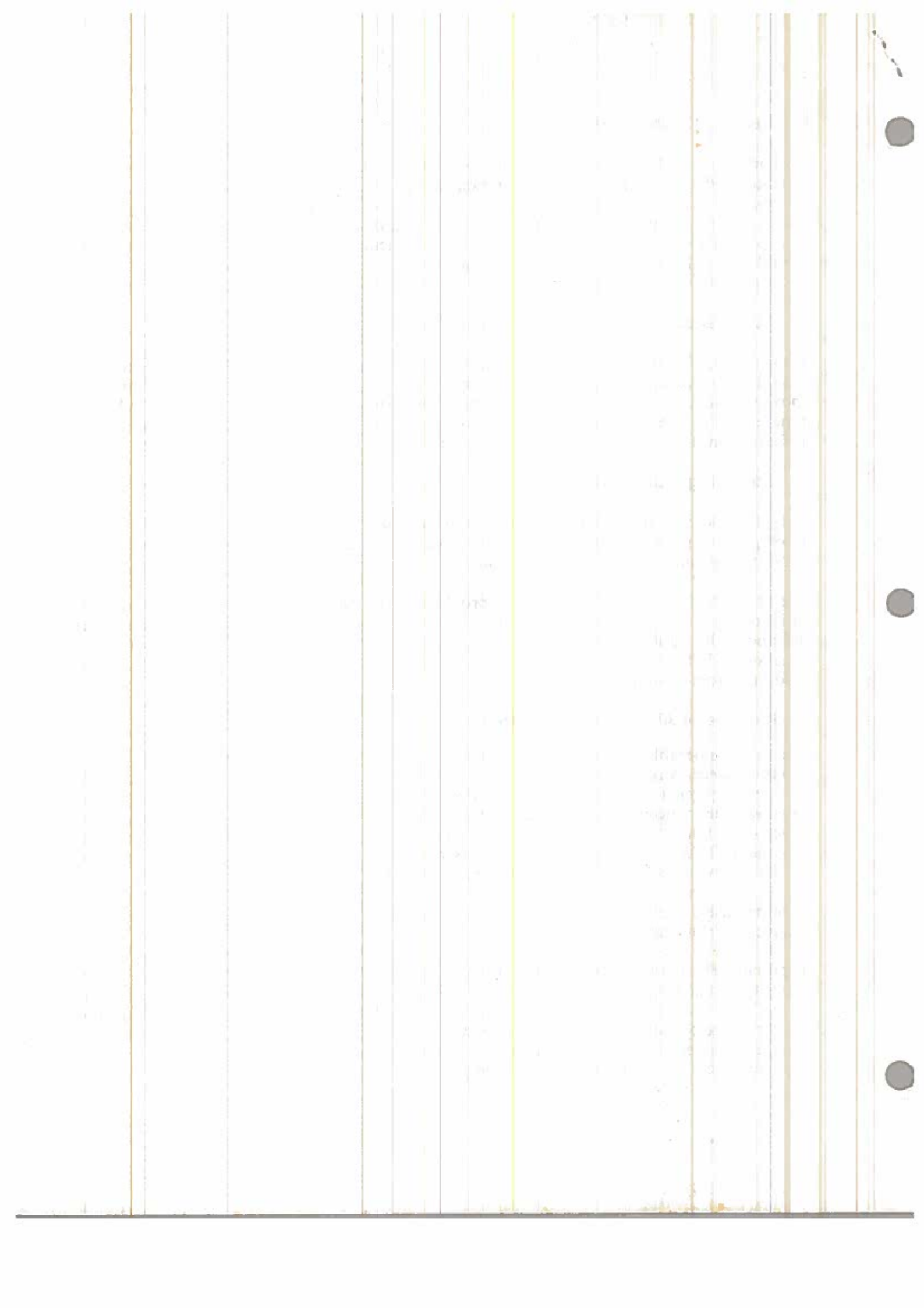
One of the best ways of curing a vortex problem is to place an anti-cavitation plate over the outlet of the reservoir. This is a common piece of sheet metal at least 1/8 inch thick set over and above the outlet opening. This plate will allow flow into the outlet from a horizontal direction and effectively extends and enlarges the reservoir opening. This prevents the vortex condition from developing.

F. Release of Air Suspended within the Fluid

There is considerable air suspended in cold hydraulic fluid. As the fluid warms, air is released into the system. A reduction of fluid pressure will also release air out of suspension. A simple relief valve poppet can create an orifice that increases velocity of the fluid and lowers its pressure. The reduced pressure condition releases air out of suspension into the system. Relief valves should be returned below the fluid level of the reservoir as far from the reservoir outlet as possible. This allows time for the air released by the relief valve to be removed before leaving the reservoir and entering the inlet area of the pump.

In some cases, special return line configurations are needed, or air bleed valves used, to remove air from the system.

A special baffle made of 60 mesh screen can be installed into the reservoir. This baffle should be positioned at a 30° angle in the reservoir so that inlet oil is above the screen and outlet oil is below the screen. The top of the screen should be below the reservoir fluid level far enough to prevent surface foam from coming in contact with the screen. Surface foam can penetrate through the screen into the outlet area. The screen baffle will eliminate all bubbles except the very small ones from the fluid if designed properly.





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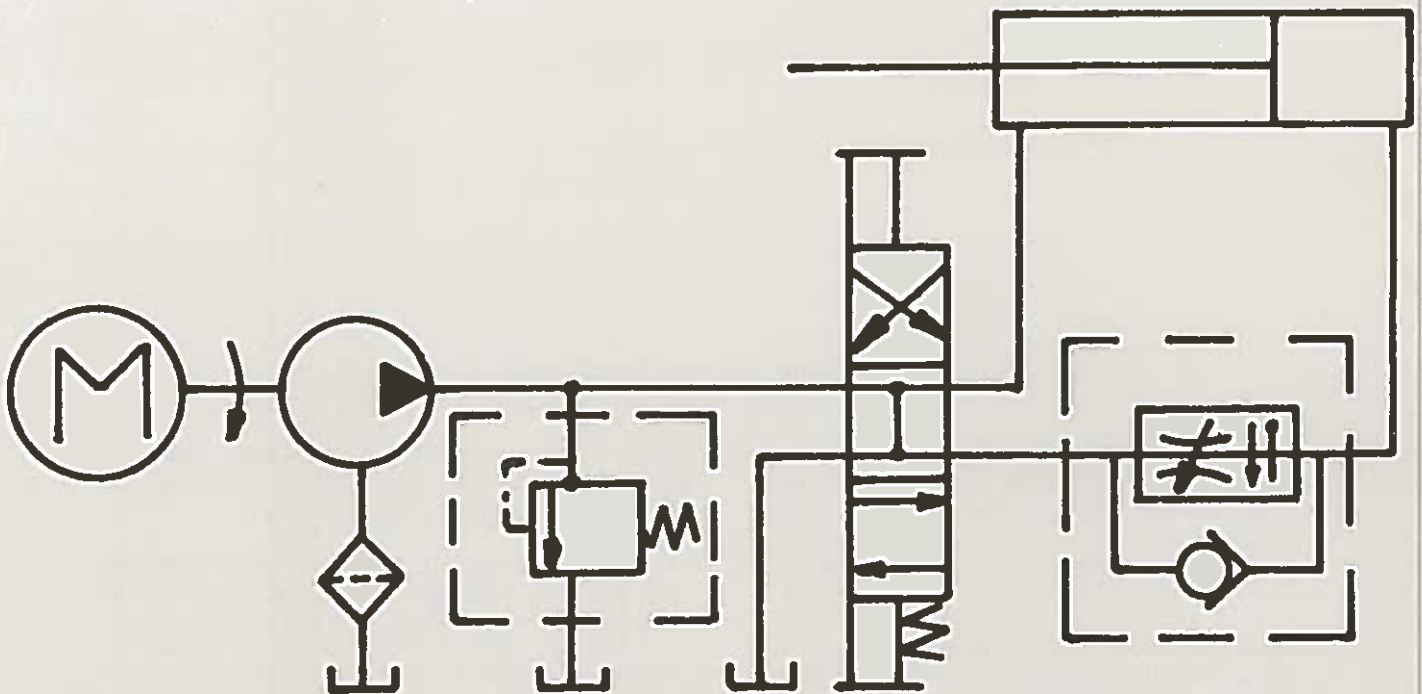


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SECTION I - INTRODUCTION

1-1. GENERAL. The trouble shooting charts and maintenance hints that follow are of a general system nature but should provide an intuitive feeling for a specific system. The more general information is covered in the immediately following paragraphs. Effect and probable cause charts appear in Section II.

1-2. SYSTEM DESIGN. There is, of course, little point in discussing the design of a system which has been operating satisfactorily for a period of time. However, a seemingly uncomplicated procedure such as relocating a system or changing a component part can cause problems. Because of this, the following points should be considered:

A. Each component in the system must be compatible with and form an integral part of the system. For example, an inadequate size filter on the inlet of a pump can cause cavitation and subsequent damage to the pump.

B. All lines must be of proper size and free of restrictive bends. Undersize or restricted line results in a pressure drop in the line itself.

C. Some components must be mounted in a specific position with respect to other components or the lines. The housing of an in-line pump, for example, must remain filled with fluid to provide lubrication.

D. The inclusion of adequate test points for pressure readings, although not essential for operation, will expedite trouble-shooting.

1-3. KNOWING THE SYSTEM. Probably the greatest aid to trouble-shooting is the confidence of knowing the system. Every component has a purpose in the system. The construction and operating characteristics of each one should be understood. For example, knowing that a solenoid controlled directional valve can be manually actuated will save considerable time in isolating a defective solenoid. Some additional practices which will increase your ability and also the useful life of the system follow:

A. Know the capabilities of the system. Each component in the system has a maximum rated speed, torque, or pressure. Loading the system beyond the specifications simply increases the possibility of failure.

B. Know the correct operating pressures. Always set and check pressures with a gauge. How else can you know if the operating pressure is above the maximum rating of the components? The question may arise as to what the correct operating pressure is. If it isn't correctly specified on the hydraulic schematic, the following rule should be applied:

The correct operating pressure is the lowest pressure which will allow adequate performance of the system function and still remain below the maximum rating of the components and machine.

Once the correct pressures have been established, note them on the hydraulic schematic for future reference.

C. Know the proper signal levels, feedback levels, and dither and gain settings in servo control systems. If they aren't specified, check them when the system is functioning correctly and mark them on the schematic for future reference.

1-4. DEVELOPING SYSTEMATIC PROCEDURES. Analyze the system and develop a logical sequence for setting valves, mechanical stops, interlocks, and electrical controls. Tracing of flow paths can often be accomplished by listening for flow in the lines or feeling them for warmth. Develop a cause and effect troubleshooting guide similar to the charts appearing in Section II. The initial time spent on such a project could save hours of system down-time.

1-5. RECOGNIZING TROUBLE INDICATIONS. The ability to recognize trouble indications in a specific system is usually acquired with experience. However, a few general trouble indications can be discussed.

A. Excessive heat means trouble. A mis-aligned coupling places an excessive load on bearings and can be readily identified by the heat generated. A warmer than normal tank return line on a relief valve indicates operation at relief valve setting. Hydraulic fluids which have a low viscosity will increase the internal leakage of components resulting in a heat rise. Cavitation and slippage in a pump will also generate heat.

B. Excessive noise means wear, mis-alignment, cavitation or air in the fluid. Contaminated fluid can cause a relief valve to stick and chatter. These noises may be the result of dirty filters, or fluid, high fluid viscosity, excessive drive speed, low reservoir level, loose intake lines, or worn couplings.

1-6. MAINTENANCE. Three simple maintenance procedures have the greatest effect on hydraulic system performance, efficiency, and life. Yet, the very simplicity of them may be the reason they are so often overlooked. What are they? Simply these:

A. Maintaining a clean sufficient quantity of hydraulic fluid of the proper type and viscosity.

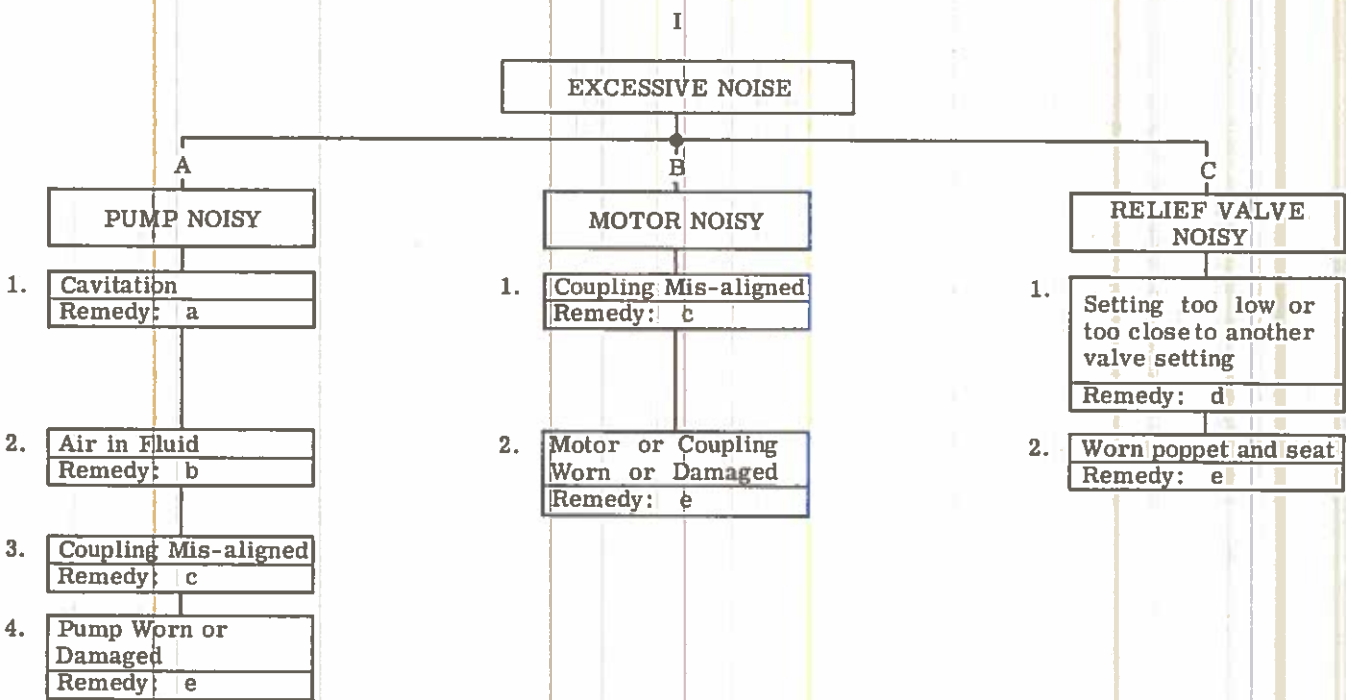
B. Changing filters and cleaning strainers.

C. Keeping all connections tight, but not to the point of distortion, so that air is excluded from the system.

SECTION II - TROUBLE-SHOOTING GUIDES

2-1. The following charts are arranged in five main categories. The heading of each one is an effect which indicates a malfunction in the system. For example; if a pump is exceptionally noisy, refer to Chart I titled EXCESSIVE NOISE. The noisy pump appears in Column A under the main heading. In

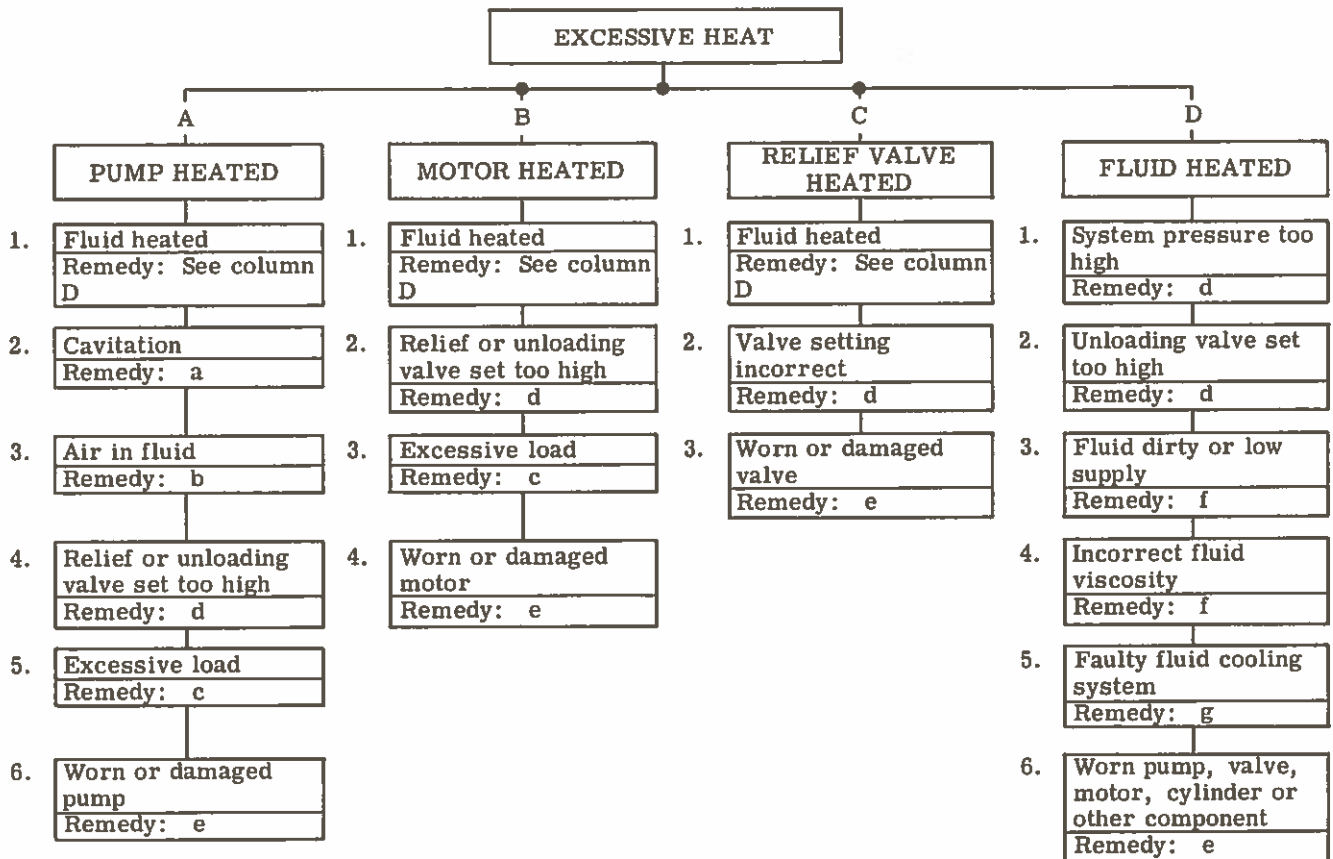
Column A there are four probable causes for a noisy pump. The causes are sequenced according to the likelihood of happening or the ease of checking it. The first cause is cavitation and the remedy is "a". If the first cause does not exist, check for cause number 2, etc.



REMEDIES:

- a. Any or all of the following: Replace dirty filters - Wash strainers in solvent compatible with system fluid - Clean clogged inlet line - Clean reservoir breather vent - Change system fluid - Change to proper pump drive motor speed - Overhaul or replace supercharge pump - Fluid may be too cold
- b. Any or all of the following: Tighten leaky inlet connections - Fill reservoir to proper level (with rare exception all return lines should be below fluid level in reservoir) - Bleed air from system - Replace pump shaft seal (and shaft if worn at seal journal)
- c. Align unit and check condition of seals, bearings and coupling
- d. Install pressure gauge and adjust to correct pressure
- e. Overhaul or replace

II

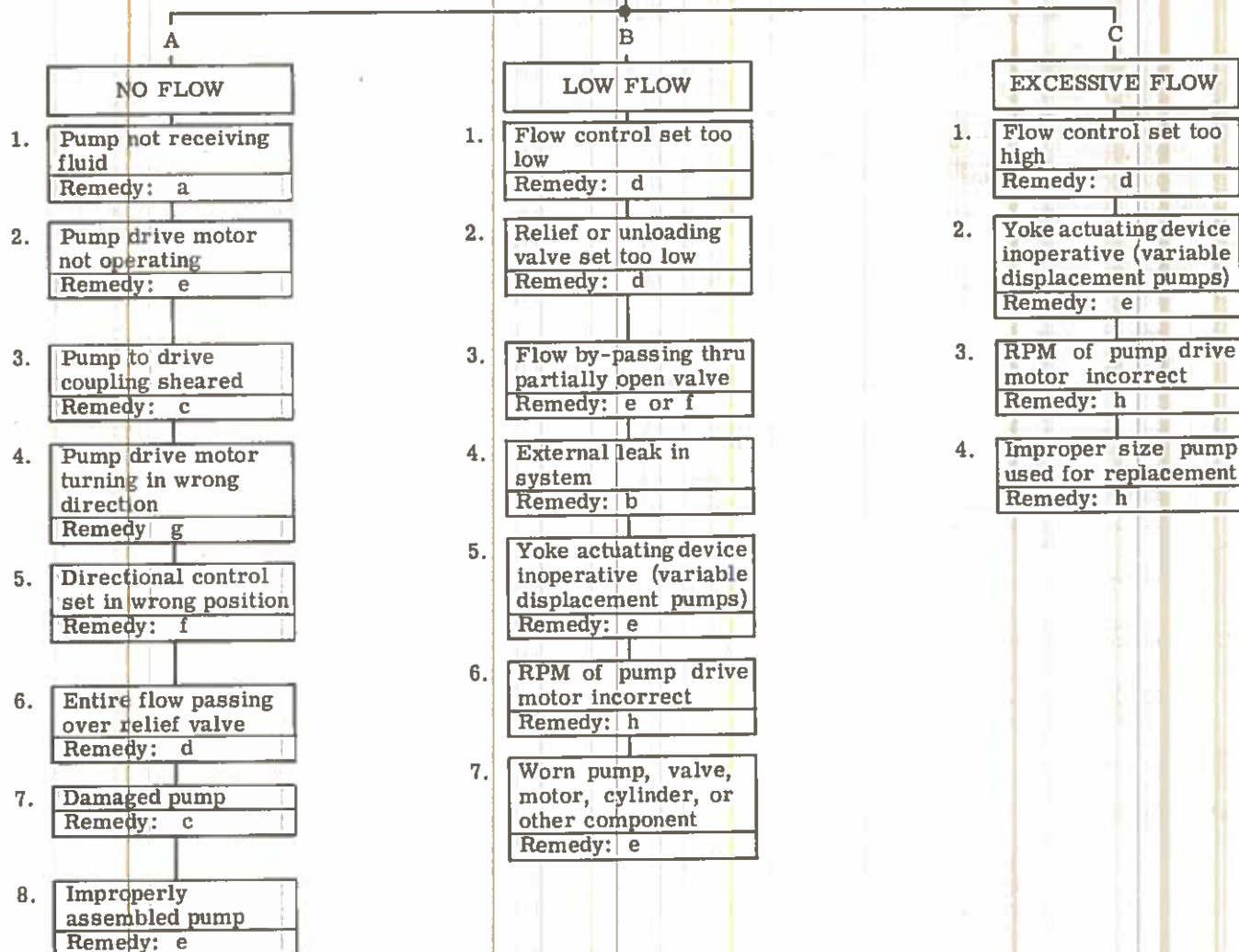


REMEDIES:

- a. Any or all of the following: Replace dirty filters - Clean clogged inlet line - Clean reservoir breather vent - Change system fluid - Change to proper pump drive motor speed - Overhaul or replace supercharge pump
- b. Any or all of the following: Tighten leaky inlet connections - Fill reservoir to proper level (with rare exception all return lines should be below fluid level in reservoir) - Bleed air from system - Replace pump shaft seal (and shaft if worn at seal journal)
- c. Align unit and check condition of seals and bearings - Locate and correct mechanical binding - Check for work load in excess of circuit design
- d. Install pressure gauge and adjust to correct pressure (Keep at least 125 PSI difference between valve settings)
- e. Overhaul or replace
- f. Change filters and also system fluid if of improper viscosity - Fill reservoir to proper level
- g. Clean cooler and/or cooler strainer - Replace cooler control valve - Repair or replace cooler

III

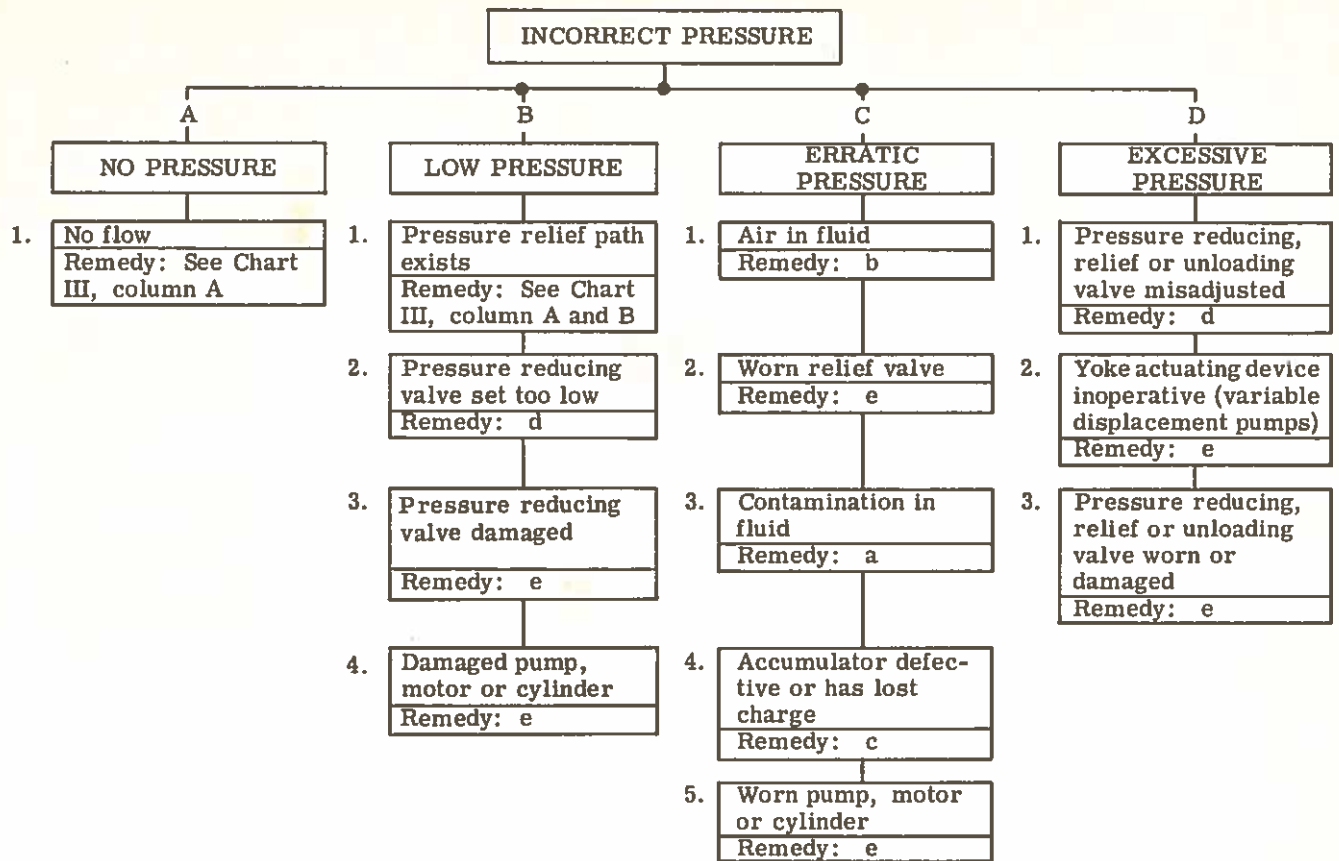
INCORRECT FLOW



REMEDIES:

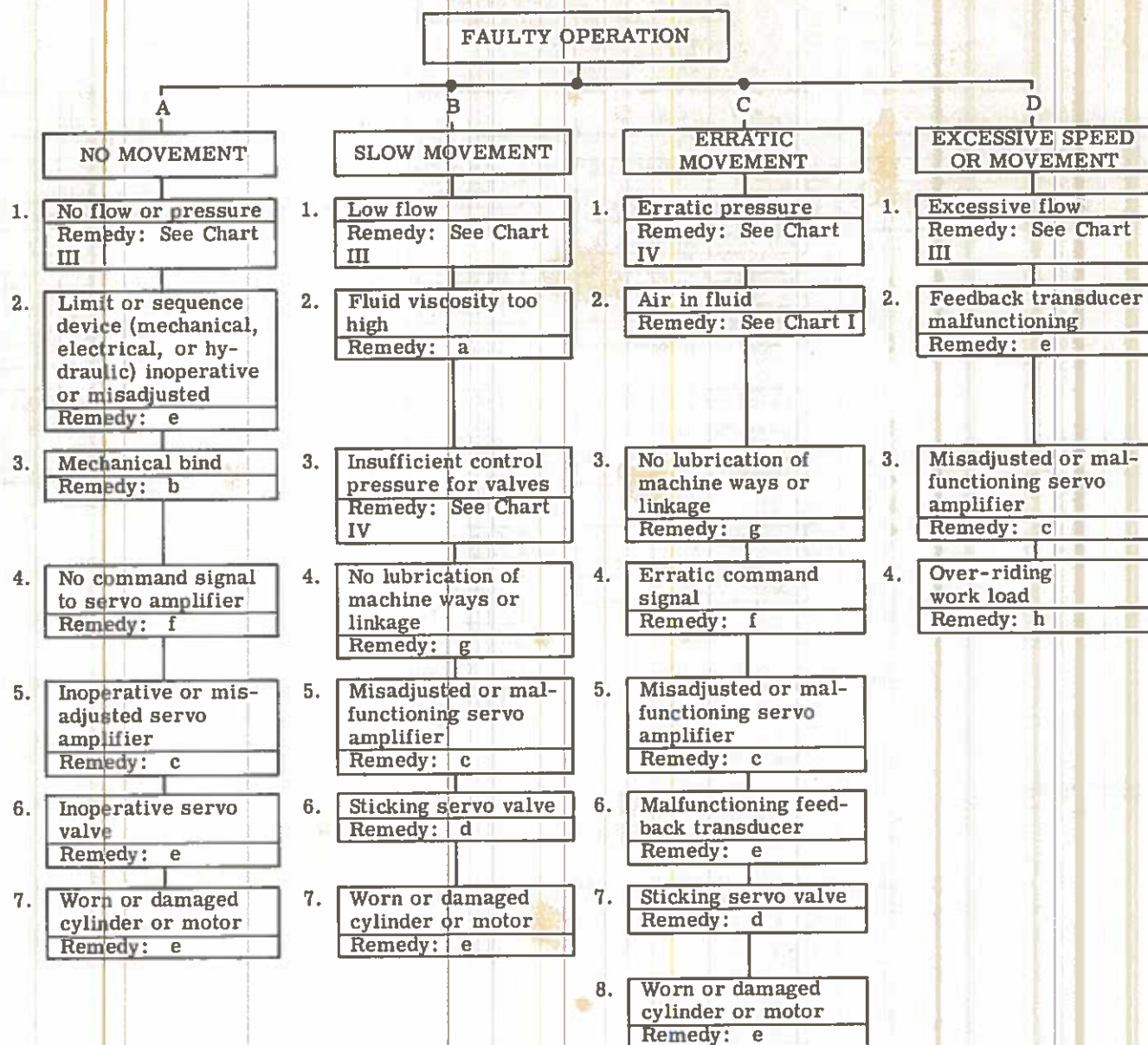
- a. Any or all of the following: Replace dirty filters - Clean clogged inlet line - Clean reservoir breather vent - Fill reservoir to proper level - Overhaul or replace supercharge pump
- b. Tighten leaky connections - Bleed air from system
- c. Check for damaged pump or pump drive - replace and align coupling
- d. Adjust
- e. Overhaul or replace
- f. Check position of manually operated controls - Check electrical circuit on solenoid operated controls - Repair or replace pilot pressure pump
- g. Reverse rotation
- h. Replace with correct unit

IV



REMEDIES:

- a. Replace dirty filters and system fluid
- b. Tighten leaky connections (fill reservoir to proper level and bleed air from system)
- c. Check gas valve for leakage - Charge to correct pressure - Overhaul if defective
- d. Adjust
- e. Overhaul or replace

**REMEDIES:**

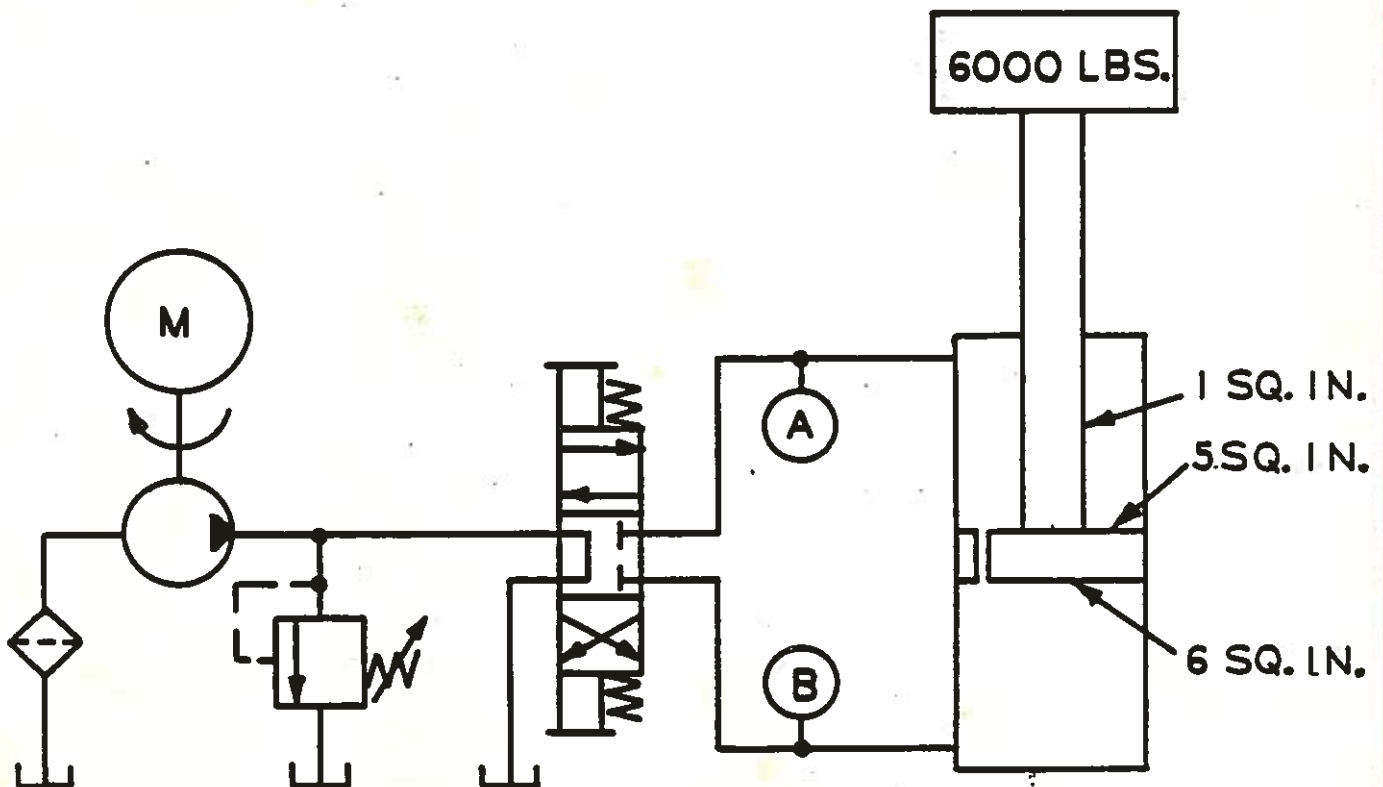
- a. Fluid may be too cold or should be changed to clean fluid of correct viscosity
- b. Locate bind and repair
- c. Adjust, repair, or replace
- d. Clean and adjust or replace - Check condition of system fluid and filters
- e. Overhaul or replace
- f. Repair command console or interconnecting wires
- g. Lubricate
- h. Adjust, repair, or replace counterbalance valve.

LEAKY CYLINDER
CLASSROOM OR HOMEWORK PROBLEM

NAME _____

A vertical cylinder having a piston with a six square inch area and a rod with a one square inch cross section has been stopped in mid stroke as shown in sketch.

1. Tandem center directional valve. Assume zero leakage at cylinder ports.
2. The piston seal is faulty, permitting leakage from one side to the other (shown in drawing as a small hole drilled through the piston).
3. Ignore the compressibility of the fluid.



QUESTIONS:

1. What will happen to load? _____
2. What will gauge "A" read? _____ PSI
3. What will gauge "B" read? _____ PSI

1941

1942

1943

1944

1945

1946

1947

1948

1949

1950

1951

1952

1953

1954

1955

1956

1957

1958

1959

1960

1961

1962

1963

1964

1965

1966

1967

1968

1969

1970

1971

1972

1973

1974

1975

1976

1977

CLASSROOM OR HOMEWORK PROBLEM

(DIFFERENTIAL CYLINDER)

Name _____

FUNCTION OF CIRCUIT

A double acting differential cylinder is used for the reciprocating motions on a machine or vehicle. The circuit is shown below.

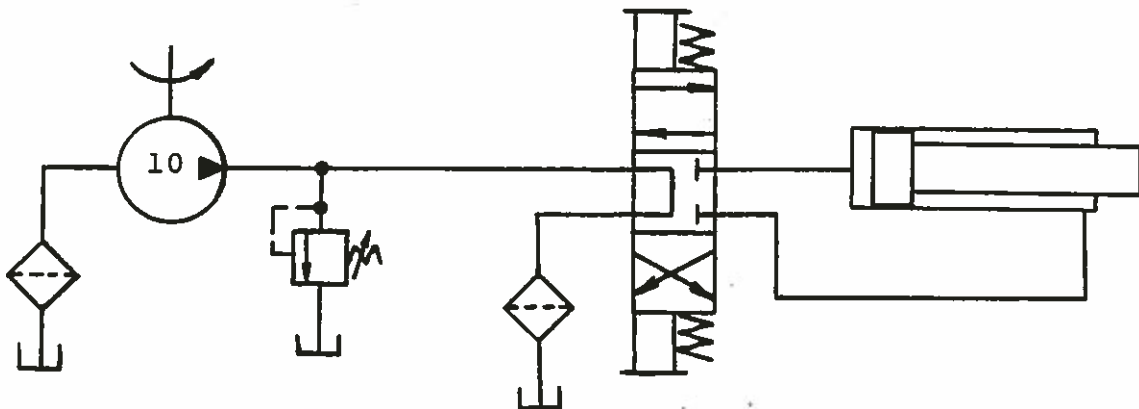
GIVEN

1. Pump delivery is 10 GPM.
2. Area ratio of cylinder is 2:1.
3. Cylinder holds 5 gallons fully extended.
4. Cylinder holds 2.5 gallons fully retracted.
5. Cylinder extension time is 30 seconds.
6. Cylinder retraction time is 15 seconds.

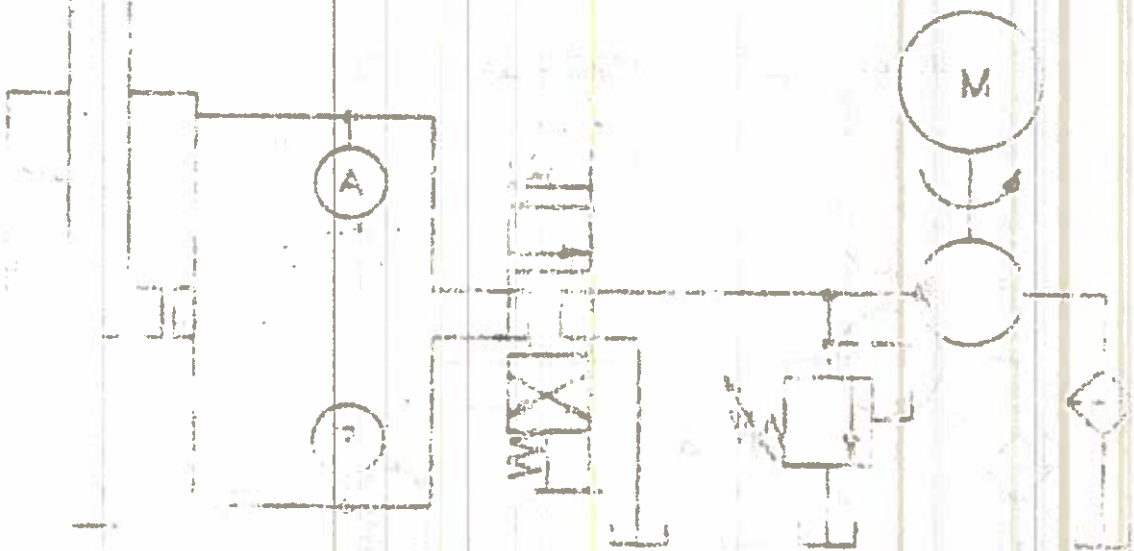
PROBLEM

Change the circuit so the cylinder will extend in 15 seconds and retract in 15 seconds.

NOTE: DO NOT CHANGE CYLINDER OR PUMP



2000 LB.



1. When the system is in the "ON" position, the motor will run and the pump will deliver water to the tank.

CLASSROOM OR HOMEWORK PROBLEM
(BASIC HYDRAULICS)

Name _____

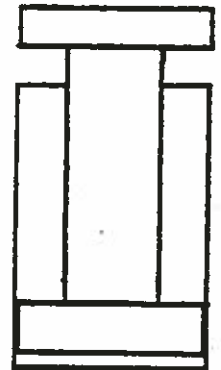
I.

1. Cylinder A has a 2" diameter, and exerts a maximum force of 3000 pounds.

- What will the force be if cylinder A is replaced by cylinder B having a diameter of 4"? _____
- Which cylinder will move faster? _____. How much faster? _____.
- Which cylinder has the most force? _____. Which has the most power? _____.
- What is the cross-sectional area? A ____? B ____?

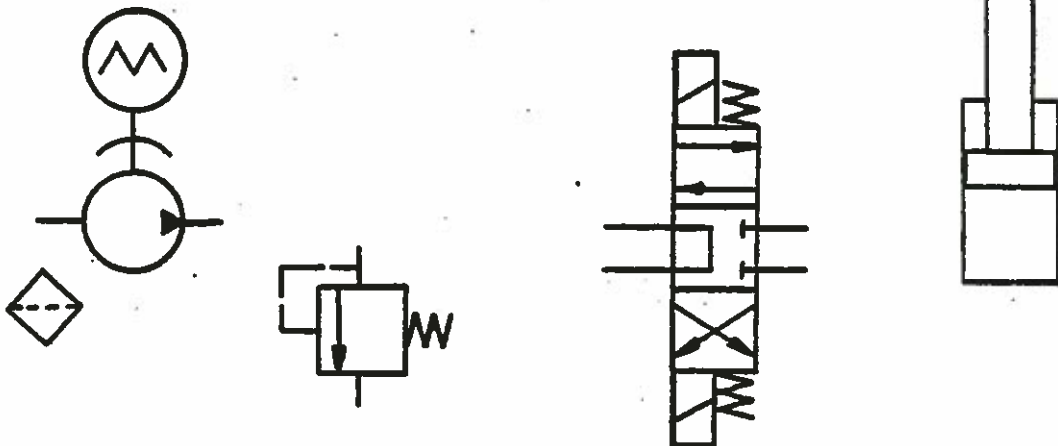


A



B

II.



1. Complete above drawing by adding necessary lines:

Given: Maximum clamping force required is 4000 lbs.. Area of cylinder is 8 square inches. Speed needed is 120 inches per minute.

- Find:
- Pressure required is _____ PSI.
 - Size of pump _____ GPM.
 - Relief valve setting _____ PSI.
 - Size of electric motor _____ H.P.,

Name _____

OBJECTIVE:

To lift a load with a handpump.

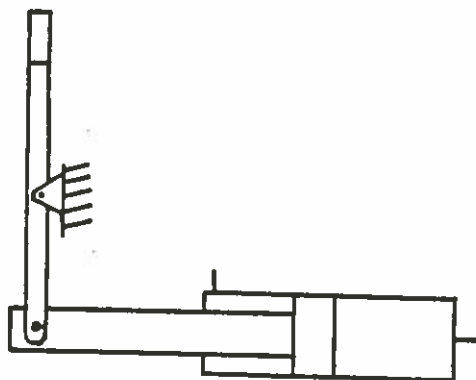
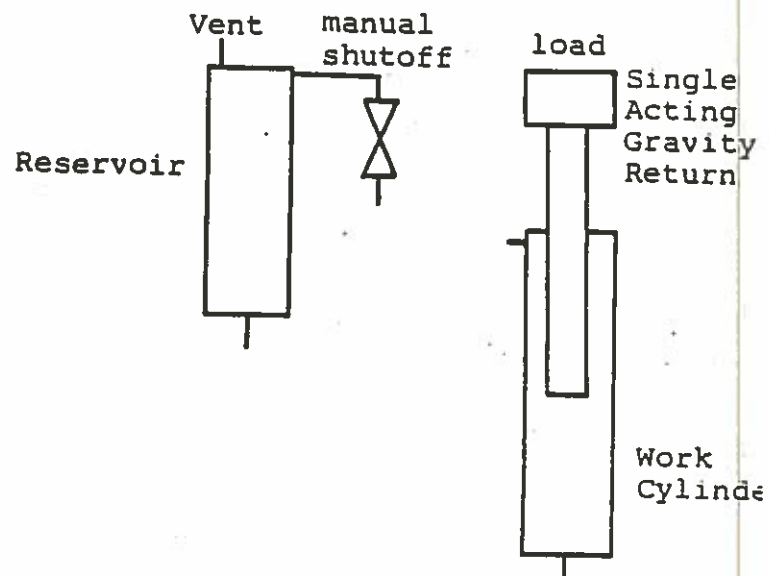
REQUIREMENTS:

With each stroke of the hand lever (forward and return) the load must raise the same amount.

Check valves are the only additional components required.

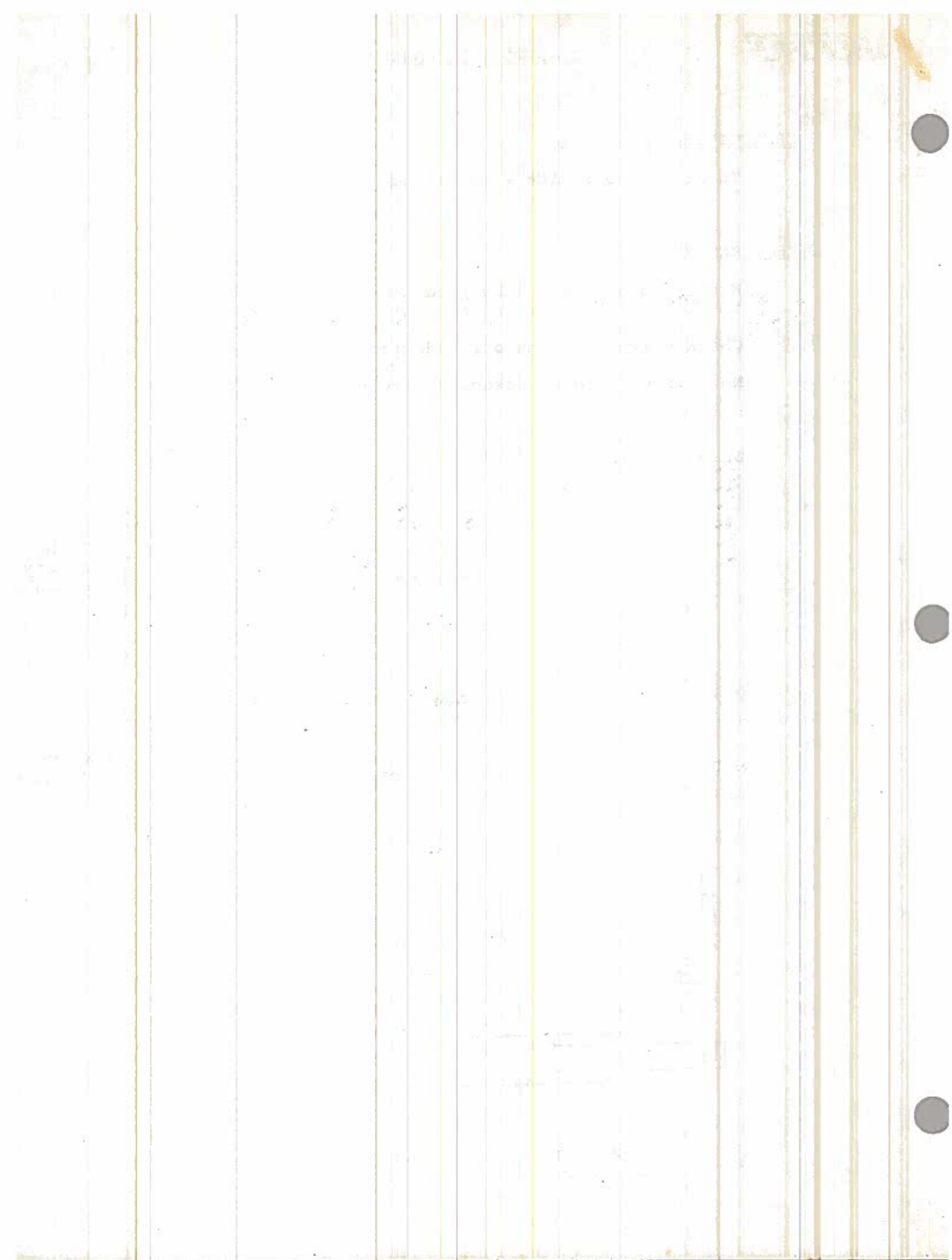
No hydraulic force needed to lower the load.

Draw the circuit:



Rod Area
1 sq. in.

Cap. Area
2 sq. in.



CARTRIDGE VALVE COURSE REVIEW

(20 Questions, Only One Answer is Correct)

1. In a cartridge type relief valve, the pilot sensing port is a:

(~~X~~)
(~~X~~)
(☒)

- a) .040 hole through the poppet.
b) Drilled passage in the manifold to tank.
c) Drilled passage in the manifold from the insert inlet port to the pilot valve.

2. In a shuttle cover the higher of two pilot pressures will be directed to the:

(~~X~~)
(☒)
(~~X~~)

- a) 'A' port of the insert.
b) Spring chamber of the insert.
c) 'B' port of the insert.

3. The 'A' port area of the insert is:

(~~X~~)
(☒)
(~~X~~)

- a) The circular area defined by the seat.
b) The circular area defined by the outside diameter of the spool.
c) The annular area between the seat and O.D. of the spool.

4. The response time of opening and closing the cartridge valve may be controlled by:

(☒)
(~~X~~)
(~~X~~)

- a) The type of cover used.
b) The size of orifice plug installed in the pilot passages of the cover.
c) The size of orifice in the main flow ports.

5. The area ratio of the spool (1:2, 1:1.1 and 1:1) compares area ____ to area ____:

(~~X~~)
(☒)
(~~X~~)

- a) Area of port 'B' to 'AP' area or B:AP.
b) Area of 'AP' to area of port 'A' or AP:A.
c) Area of 'A' port to area of 'AP' or A:AP.

$$\begin{aligned}AP &= A \\AP - A &= B \\AP &= A + B \\B &= 1.1 - 1 \\&= .1 \\A : AP &= .1 \\A + B &= AP.\end{aligned}$$

6. When a pilot operated check valve cover is used with an insert it will require at least _____ system pressure to act as the pilot pressure:

- a) One third.
- b) One half.
- c) Full.

7. Figures 1 and 2 show a cartridge valve connected in the circuit as a non-return check valve. Which circuit will prevent cylinder creep due to valve leakage?

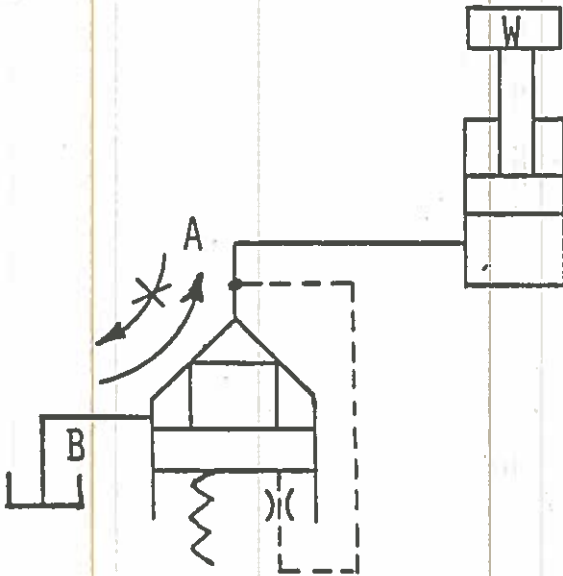


Figure 1

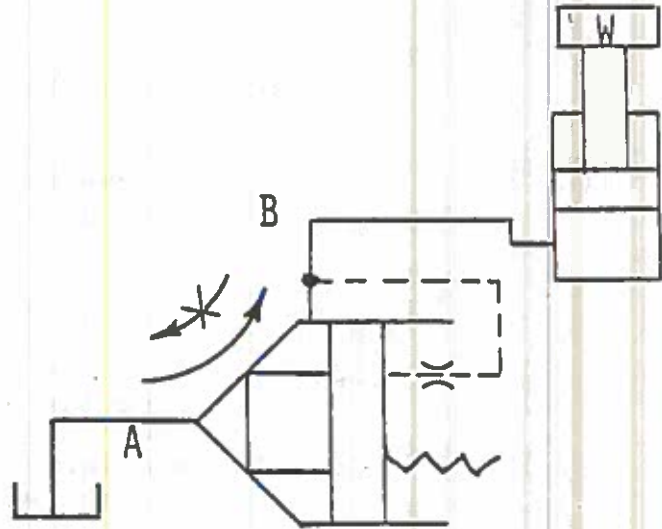


Figure 2

- a) Figure 1.
- b) Figure 2.

8. Covers with pilot directional valve interface have an auxiliary port (Z1 or Z2) which may be connected in the manifold to:

- a) Supply main insert spring chamber pressure.
- b) Other valve pilots giving simultaneous operation of more than one cartridge valve.
- c) Supply the higher of two pressures to the main insert spring chamber pressure.

9. A cartridge valve with stroke adjust cover is used to provide:
- a) Pressure control.
 - b) Higher flow capability.
 - c) Flow regulation and directional control.

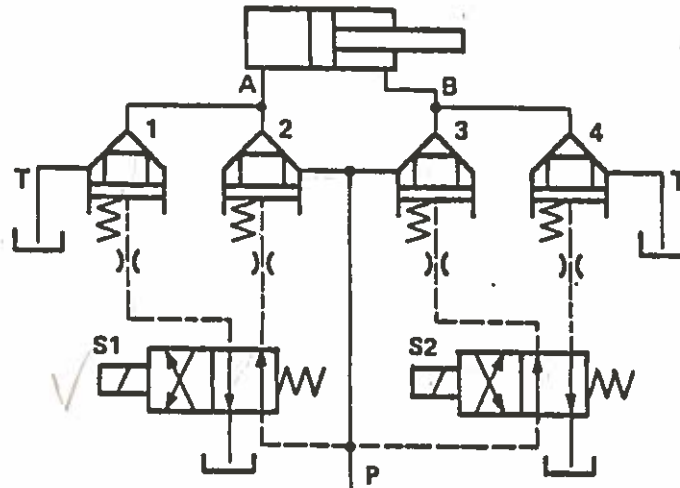


Figure 3

10. To provide a regenerative condition in the circuit as shown in Fig. 3, solenoids:

- a) S1 and S2 should be de-energized.
- b) S1 should be energized and S2 de-energized.
- c) S1 and S2 should be energized.

11. The cartridge type relief valve may be:

- a) Used without a manifold.
- b) Vented or controlled remotely.
- c) Only used in low pressure systems.

12. There are three springs available with each insert kit. Using a 1:2 insert, the cracking pressure is 0.5, 2.5, or 5 bar. The equivalent in PSI is:

- a) 5, 25, or 50 PSI.
- b) 7.25, 36.25, or 72.5 PSI.
- c) 5, 50, or 100 PSI.

14.5

13. The inserts are rated for flow at a pressure drop of 1 or 5 bar. This pressure drop is through:

- a) The manifold inlet to outlet port.
- b) The 'A' port to 'X' port.
- c) The inserts ports 'A' to 'B'.

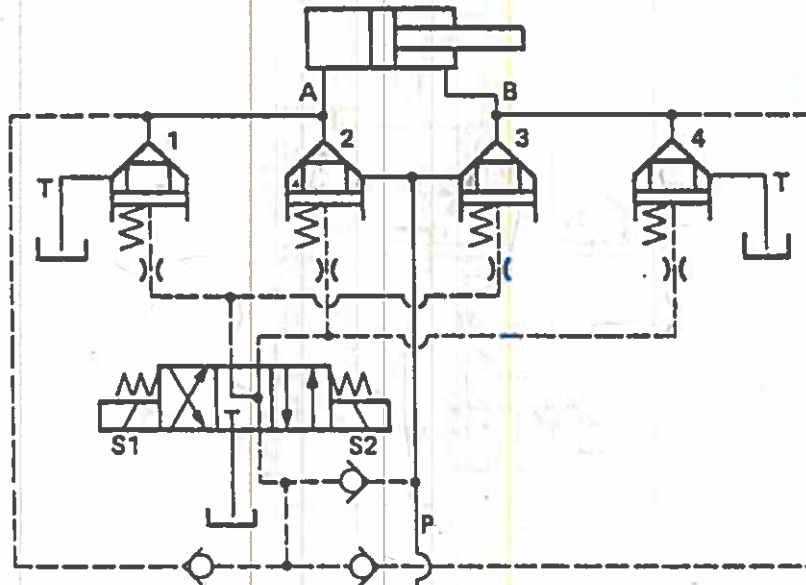


Figure 4

14. Adding three check valves to the pilot circuit as shown in Figure 4 provides an equivalent spool valve center condition of:

- a) Open center.
- b) Closed center.
- c) Tandem center.

15. For finer control of flow with a stroke adjust cover a _____ type poppet is used.

- a) 1:2 damping.
- b) 1:2.
- c) 1:1.

16. With a 1:1 area ratio insert, the 'B' area is:

- a) Equal to the 'A' area.
- b) Equal to zero.
- c) Equal to the 'AP' area.

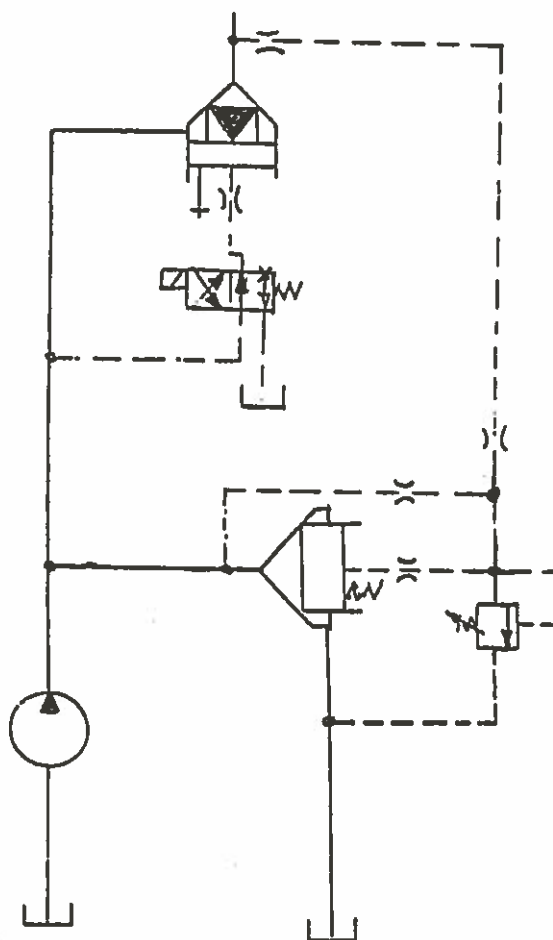


Figure 5

17. The circuit in Figure 5 provides an ON OFF flow condition by the directional valve plus a:

- () a) Pressure compensated flow control with maximum pressure relief.
- () b) Non-pressure compensated flow control and pressure relief.
- (✓) c) Pressure reducing valve.

18

The cartridge type relief valve may be assembled with manual pressure adjuster and DO-1 interface cover plus pressure relief module to provide:

- a) A single pressure system.
- b) Two pressures plus venting.
- c) Three pressures plus venting.

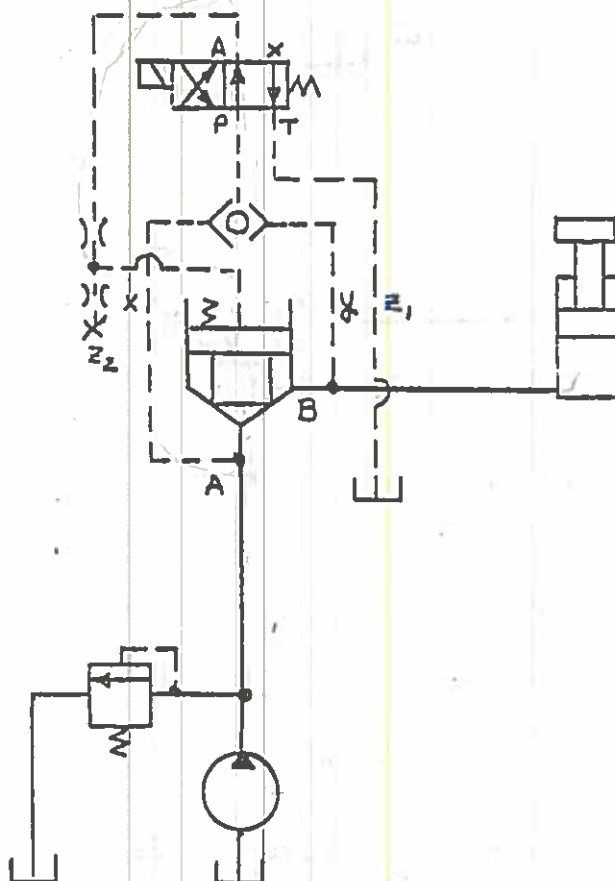


Figure 6

19. In Figure 6 with the pump running and the directional valve in the spring offset position the:

- a) Load will cause the cylinder to retract.
- b) Pump flow will cause cylinder to extend.
- c) Cartridge insert will remain closed.

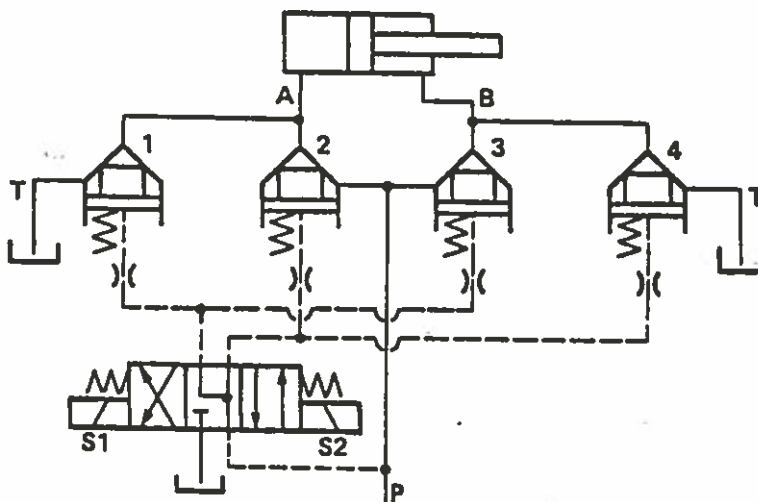
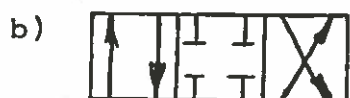


Figure 7

20. The equivalent spool valve for the circuit in Figure 7 is:



Handwritten notes in a cursive script, likely from a 19th-century manuscript. The text is written in dark ink on aged, slightly yellowed paper. The handwriting is fluid and characteristic of the period. The notes are organized into several paragraphs, with some lines indented. The paper shows signs of wear, including faint smudges and a vertical crease down the center.

CARTRIDGE VALVE
Test Answer Sheet

	A	B	C
1.	()	()	()
2.	()	()	()
3.	()	()	()
4.	()	()	()
5.	()	()	()
6.	()	()	()
7.	()	()	()
8.	()	()	()
9.	()	()	()
10.	()	()	()
11.	()	()	()
12.	()	()	()
13.	()	()	()
14.	()	()	()
15.	()	()	()
16.	()	()	()
17.	()	()	()
18.	()	()	()
19.	()	()	()
20.	()	()	()



PVD, PVE PISTON PUMP AND CONTROL TEST

(50 Questions, Answer Either True or False)

True False

To change the direction of drive shaft rotation of a PVD or PVE pump:

- | | A | B | |
|----|---|-------|---|
| 1. | (☒) | () | Will require a gear pump (if used), valve plate and valve block change. |
| 2. | (☒) | () | Will not require a part change. |

The valve plate of a PVD and PVE piston type pump seats against:

- | | | | |
|-----|---|---|-------------------------|
| X3. | () | (☒) | The control piston. |
| 4. | (☒) | () | Variable yoke assembly. |
| 5. | (☒) | () | The valve block. |

'D' and 'E' series piston type pumps are rated (in RPM) for comparison purposes at:

- | | | | |
|-----|---|-------|-----------|
| X6. | (☒) | () | 2400 RPM. |
| 7. | (☒) | () | 1800 RPM. |
| X8. | (☒) | () | 2000 RPM. |

The piston shoes of PVD and PVE piston type pumps ride up against:

- | | | | |
|------|---|---|------------------------------|
| 9. | () | (☒) | Valve plate assembly. |
| X10. | (☒) | () | Cylinder block assembly. |
| 11. | () | (☒) | Swash plate - yoke assembly. |

The gear pump on a PVD piston type pump is:

- | | A | B | |
|------|---|---|---|
| X12. | () | (☒) | Hydraulically unbalanced. |
| X13. | (☒) | () | Externally drained. |
| ✓14. | (☒) | () | Helps supercharge the inlet of the piston pump. |

'D' and 'E' piston type pumps are drained from the top part of the case to:

- | | | | |
|------|---|---|--|
| 15. | () | (☒) | Limit yoke movement. |
| 16. | (☒) | () | Keep the housing full of oil at all times. |
| X17. | (☒) | () | Avoid cavitation. |

True False

Smearing or scratching of the valve plate in a 'D' or 'E' series piston type pump could be caused by:

- | | | | |
|-------|-----|-----|---------------------------|
| 18. | () | (✓) | Properly filtered oil. |
| X 19. | () | (✓) | Cylinder block lift. |
| 20. | (✓) | () | Contamination in the oil. |
| 21. | () | (✓) | Control piston lift. |

The force to hold the piston shoes up against the swash plate in a PVD type pump comes from:

- | | | | |
|-------|-----|-----|--|
| 22. | (✓) | () | Shoe retainer plate and charge pressure. |
| 23. | () | (✓) | The cylinder block spring. |
| X 24. | (✓) | () | Valve plate. |

The torque summation type control:

- | | | | |
|-------|-----|-----|--|
| X 25. | () | () | Allows two pumps with more horsepower requirement than the prime mover can put out, operate without overloading. |
| 26. | (✓) | () | Allows either pump to operate at full capacity. |
| 27. | (✓) | () | Requires pressure sensing lines to be connected between the pumps. |
| 28. | (✓) | () | Requires no parts modifications to the existing pressure compensator. |

Improper adjustment (too loose or too tight) of the yoke pintle bearings will:

- | | | | |
|-----|-----|-----|--------------------------------------|
| 29. | (✓) | () | Decrease bearing life. |
| 30. | (✓) | () | Affect yoke assembly, force to move. |
| 31. | () | (✓) | Not affect the movement of the yoke. |

The pressure compensator as used with a 'D' and 'E' series pump:

- | | | | |
|-----|-----|-----|---|
| 32. | () | (✓) | Limits the <u>minimum</u> pressure in a system. |
| 33. | (✓) | () | Has a spring offset, sliding spool. |

True False

The purpose of a load sense type pump control is to:

34. () ^A (☒) ^B Limit maximum pressure in a system.
35. (☒) () To allow pump output delivery to exactly meet system flow demands.

A load sense type pump control valve:

36. (☒) () Requires the use of a special directional valve.
X 37. (☒) () Sends a hydraulic signal to the bias piston to move the pump yoke.

The drive shaft bearings on the PVD and PVE pumps are:

38. (☒) () Taper roller bearings with end play.
39. () (☒) Preloaded ball bearings.
X 40. (☒) () Preloaded taper roller bearings.

The torque limiter type pump control:

41. () (☒) Does not need a feedback pressure signal to operate.
42. () (☒) Is not adjustable.
43. (☒) () Is adjustable.
44. (☒) () Is used when stalling of the prime mover is to be avoided.

45. (☒) () A PVD pump may have a pressure compensator, load sensing and torque limiting controls at the same time.

X 46. (☒) () The PVD pressure compensator is a single stage valve.

X 47. (☒) () A PVD pump uses a gear pump to provide a higher outlet pressure capability of the piston pump.

48. (☒) () 'D' and 'E' series piston type pumps are normally externally drained.

49. () (☒) 'D' and 'E' series piston type pumps take in oil from the inlet port which is smaller than the outlet port.

50. (☒) () PVD piston pumps can be used in electro-hydraulic control applications.

28

-LABORATORY WORK SHEET-

VARIABLE IN-LINE UNITName SANNI ADNANI. PRELIMINARY OBSERVATION

- A. Model number PVB5-FR/SY-20-C-11
- B. Pump ✓ Motor
- C. Mounting FOOT MOUNTING.
- D. Direction of rotation C.C
- E. Nominal GPM from model number 5 GPM at 1800 RPM.
- F. Type of control Pressure Compensator.

II. DISASSEMBLY

A. Lever Control, If Equipped

1. Remove four hex head bolts in valve plate subassembly.
2. Remove valve plate.

B. Compensator, If Equipped

1. Remove four compensator mounting screws.
2. Remove compensator subassembly and gasket.
3. Disassemble compensator by removing adjusting screw, spring, seat, and spool. Check condition of spool:
Usable ✓ Replace
4. Remove four hex head bolts in valve plate subassembly.
5. Remove valve plate, spacer, piston rod and piston.

C. Inspection

1. Examine piston and piston rod assembly of compensator for wear: Usable ✓ Replace
2. Examine needle bearing for wear: Good ✓ Replace
3. Examine valve plate face for wear:
Usable ✓ Rework Replace

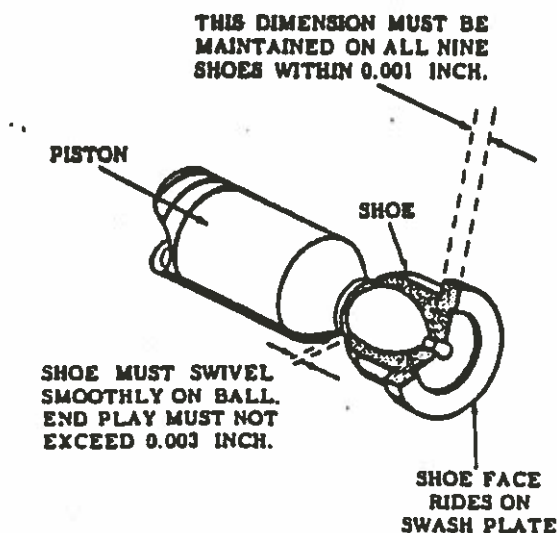
Note: Valve plate should not be reworked if pump is operated above 1500 PSI or with fluids other than recommended on installation drawings. Valve plates which can be lapped should be done by hand. Excessive lapping will remove hardened surface.

II. DISASSEMBLY (CONTINUED)

D. Remove rotating group. Caution: Tilt unit so that drive shaft is horizontal and carefully remove the complete rotating group subassembly.

E. Disassembly - rotating group

1. Grasp shoe hold down plate and remove all pistons simultaneously from their bores.
2. Remove spherical washer and flat washer from atop the force transmitting pins.
3. Remove three pins.
4. Remove piston subassembly from shoe plate.
5. Check shoe and piston assembly for end play. (Not to exceed .003".) Usable ☒ Replace ☐
6. Check piston shoes. (Maximum allowable variance between all shoes .001".) Usable ☒ Rework ☐
7. Check sealing surface on under side of shoes for wear. Usable ☒ Rework ☐ Replace ☐



8. Examine cylinder block face for wear:
Usable ☒ Rework ☐ Replace ☐
(If cylinder block needs lapping, not more than .010" should be removed.)

THESE ARE THE THINGS THAT I HAVE CHOSEN

TO LIVE BY

THEY ARE THE THINGS THAT I HAVE CHOSEN

TO LIVE BY

THEY ARE THE THINGS THAT I HAVE CHOSEN

TO LIVE BY

THEY ARE THE THINGS THAT I HAVE CHOSEN

TO LIVE BY

THEY ARE THE THINGS THAT I HAVE CHOSEN

TO LIVE BY

THEY ARE THE THINGS THAT I HAVE CHOSEN

TO LIVE BY

THEY ARE THE THINGS THAT I HAVE CHOSEN

TO LIVE BY

II. DISASSEMBLY (CONTINUED)

F. Drive shaft removal and inspection.

1. Remove large snap ring at shaft end.
USE CAUTION: Keep snap ring contained.
2. Remove drive shaft and bearing subassembly from housing.
3. Check ball bearing for roughness: Usable____ Replace____
4. Inspect needle bearing and shaft seal contact areas on drive shaft for wear: Usable____ Replace____

III. LIST MISSING PARTS AND NOTIFY INSTRUCTOR

IV. REASSEMBLY OF UNIT

- A. Make sure all parts are clean, free from burrs and fit smoothly together. Use no undue force. Swash plate may tend to cock in bore during reassembly. Care should be taken to make sure that it is properly seated before and after installing rotating group. This can be checked by firmly pressing on cylinder block face and compressing spring so that the cylinder block face is flush with pump housing.

V. CHECK WITH INSTRUCTOR

VI. SHOW PUMP IN GRAPHIC FORM



APPENDIX OF UNIT

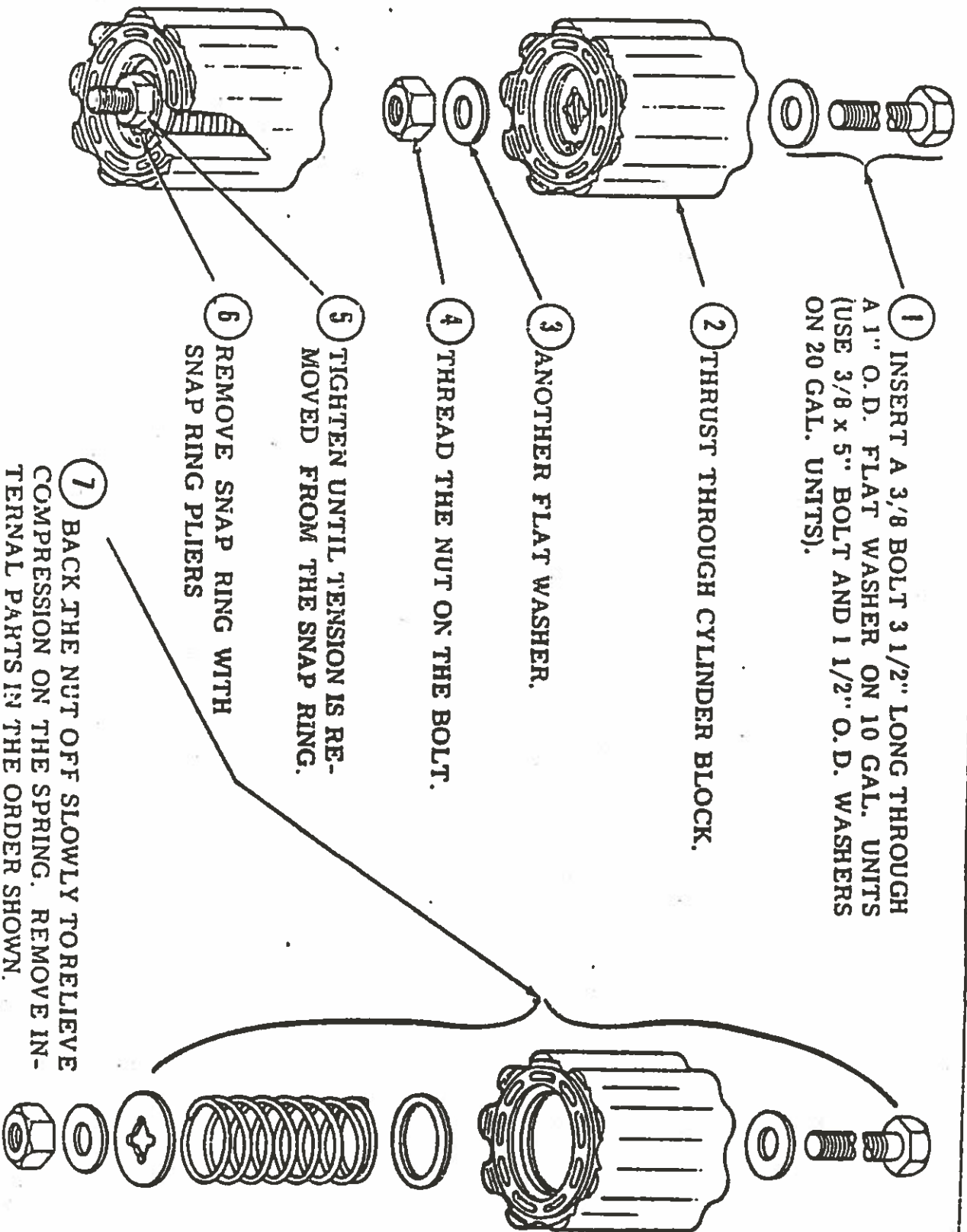
1. Take care of the data the circuit is
2. Use the data to find the
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7. Use the data to find the
8. Use the data to find the
9. Use the data to find the
10. Use the data to find the

APPENDIX OF UNIT

APPENDIX OF UNIT

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10. Use the data to find the

PROCEDURE FOR CYLINDER BLOCK DISASSEMBLY. (WHEN NECESSARY).



RECEIVED

25
WITH

TO THE
RECEIVED

THE BOLT

HTB



MOBILE VALVES - FLOW, PRESSURE, AND DIRECTIONAL

TRUE FALSE

A relief valve is used to:

- | | A | B | |
|-----------|-----|-----|---|
| 1 () | (✓) | () | Limit maximum system pressure. |
| (X) 2 (✓) | (✓) | (✓) | Limit the force of a hydraulic cylinder or the torque of a motor. |
| 3 () | () | (✓) | Control the speed of a cylinder or motor. |

Compound or balanced piston type relief valves:

- | | A | B | |
|-------|-----|-----|--|
| 4 (✓) | (✓) | () | Have low pressure override. |
| 5 (✓) | (✓) | () | Maintain a relatively constant maximum pressure regardless of flow rate though valve (within flow rating). |
| 6 (✓) | (✓) | () | Allow only a small portion of the pump flow to pass over the control poppet. |

Flow control valves are used to:

- | | A | B | |
|-------|-----|-----|---|
| 7 () | () | (✓) | Control the displacement of the pump. |
| 8 (✓) | (✓) | () | Control the speed of a hydraulic cylinder or motor. |

VICKERS FM3 *** flow controls are:

- | | A | B | |
|-----------|-----|-----|---|
| (X) 9 (✓) | (✓) | () | Adjustable during operation. |
| 10 (✓) | (✓) | () | By-pass type valves. |
| 11 (✓) | (✓) | () | Pressure compensated. |
| 12 (✓) | (✓) | () | Also pressure limiters (relief valves). |

Flow control valves are used in power steering to:

- | | A | B | |
|------------|-----|-----|--|
| (X) 13 () | () | (✓) | Permit use of smaller steering valves. |
| 14 (✓) | (✓) | () | Keep horsepower losses down. |
| 15 (✓) | (✓) | () | Prevent flow to power steering valve from exceeding a predetermined maximum. |

The following questions pertain to the CM11, CM2 & 3 type Directional valves.

The valve sections in one bank of the CM2, CM3 or CM11 directional controls are usually connected in:

- | | A | B | |
|--------|-----|-----|-----------|
| 16 () | () | (✓) | Series. |
| 17 (✓) | (✓) | () | Parallel. |

TRUE FALSE

- (X) 18 (✓) () The valve spools in any bank can only be operated one at a time.
- 19 (✓) () A by-pass passage permits unloading of the pump when all the spools are in the neutral position.
- (X) 20 (✓) () The more valve sections in a bank, the lower the pressure at the pump outlet when the valves are in neutral.

A "D" type (double-acting) spool:

- 21 () (✓) Has both cylinder ports open to tank in the neutral position.
- 22 (✓) () Is usually used with double-acting cylinders.
- 23 (✓) () Has both cylinder ports blocked in the neutral position.
- 24 () (✓) Cannot be used when it is desired to unload the pump delivery when in neutral position.

A "T" or "W" type spool (single acting):

- 25 (✓) () Permits unloading of the pump in the neutral position.
- 26 (✓) () Permits unloading of the pump when lowering a gravity return cylinder.
- 27 () (✓) Is usually used with hydraulic motors.
- 28 (✓) () Should be used with rams or cylinders that are returned mechanically or by gravity.

Check valves in each section of the multiple unit valves:

- 29 (✓) () Prevent loads from dropping when spools are shifted from the neutral position.
- 30 (✓) () Prevent interaction between loads when the spools are shifted.
- (X) 31 () (✓) Are not included in sections which have a "B" type spool for hydraulic motors.
- 32 () (✓) Limit the maximum pressure in each section.

The flow control orifice in the inlet section of the valves:

- (X) 33 (✓) () Is used to control speed of the load.
- 34 (✓) () Helps to reduce the pressure drop through the valve in the neutral position.
- 35 (✓) () Limits the flow through the by-pass passage to a predetermined value.
- 36 (✓) () Is not adjustable.

TRUE FALSE

The relief valve in the inlet section of the directional control is:

- | | A | B | |
|--------|-----|-----|--|
| (X) 37 | (✓) | () | Of the simple type. |
| 38 | (✓) | () | Used in conjunction with the flow control orifice. |
| (H) 39 | () | (✓) | Preset at the factory for pressures up to 2500 PSI. |
| 40 | (✓) | () | Automatically vented when all valve spools are centered. |

Two banks of directional valves may be connected in tandem:

- | | A | B | |
|--------|-----|-----|--|
| 41 | (✓) | () | To permit operation of both banks from the same pumping source. |
| 42 | () | (✓) | But they will require a separate relief valve in each inlet section. |
| (H) 43 | () | (✓) | To permit either bank to be operated at any time. |
| 44 | (✓) | () | To permit unloading of the pump when both banks are in the neutral position. |

The cylinder port relief and anti-cavitation check valve:

- | | A | B | |
|----|-----|-----|--|
| 45 | (✓) | () | Provides overload protection and braking of the load when used with a hydraulic motor and "D" spool. |
| 46 | (✓) | () | Prevents a motor or cylinder from cavitating. |
| 47 | () | (✓) | Should be used with a "B" (motor) spool. |

The cylinder port relief valve:

- | | A | B | |
|--------|-----|-----|--|
| (H) 48 | (✓) | () | Setting may be higher than the main system relief. |
| 49 | () | (✓) | Setting may be lower than the main system relief. |
| 50 | (✓) | () | Is used only with "B" spool valve sections. |

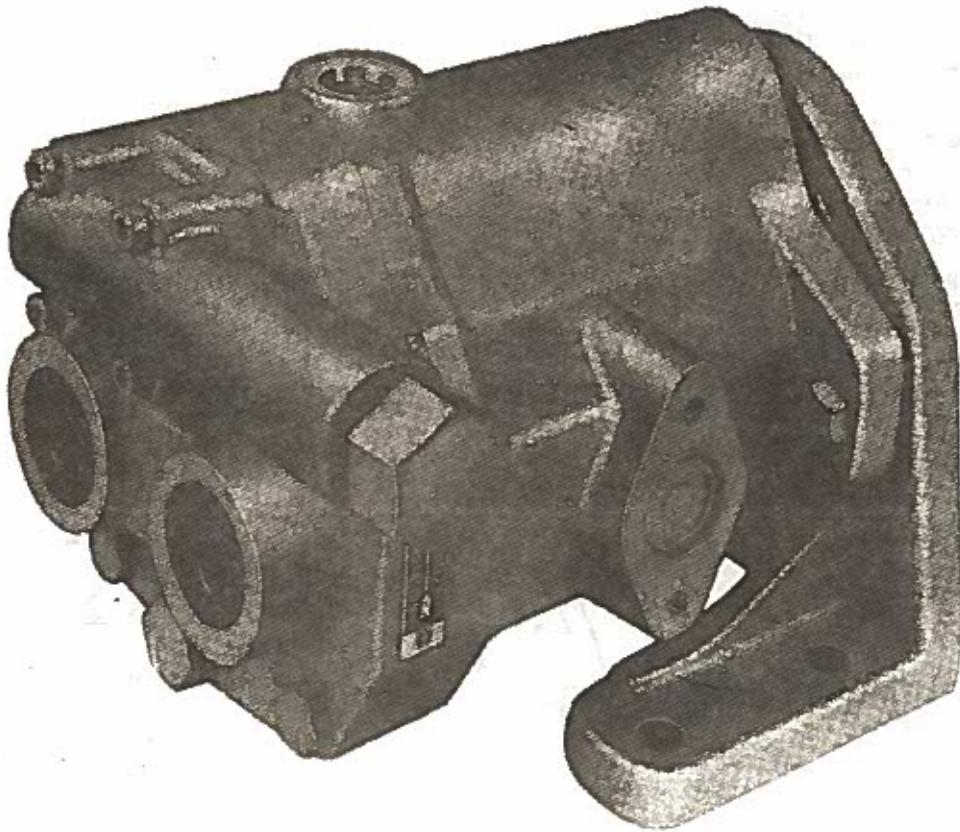
76

VICKERS

Service Parts Information

**5 and 6 GPM
Variable Inline
Piston Units**

MVB5-(F)UDY-20-*(L)-10
PVB5-(F)**Y-20-*(C)(*)-1*
PVB6-(F)**Y-20-*(C)(*)-1*



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48084

Revised 6-1-85

I-3280-S

A Libbey-Owens-Ford Company

PRESS BEARING FLUSH
WITH INSIDE SURFACE
OF HOUSING

YOKE

HOUSING

PINTLE BEARING ASSEMBLY NOTE
MAKE CERTAIN THE BEARING O. D. SURFACE
AND THE MATING SURFACE IN THE HOUSING
IS CLEAN. APPLY SEALING COMPOUND
(LOCTITE A (10-1) OR EQUIVALENT) TO THE
BEARING O. D. AND PRESS IN PLACE.

319243 PINTLE
(REF.)

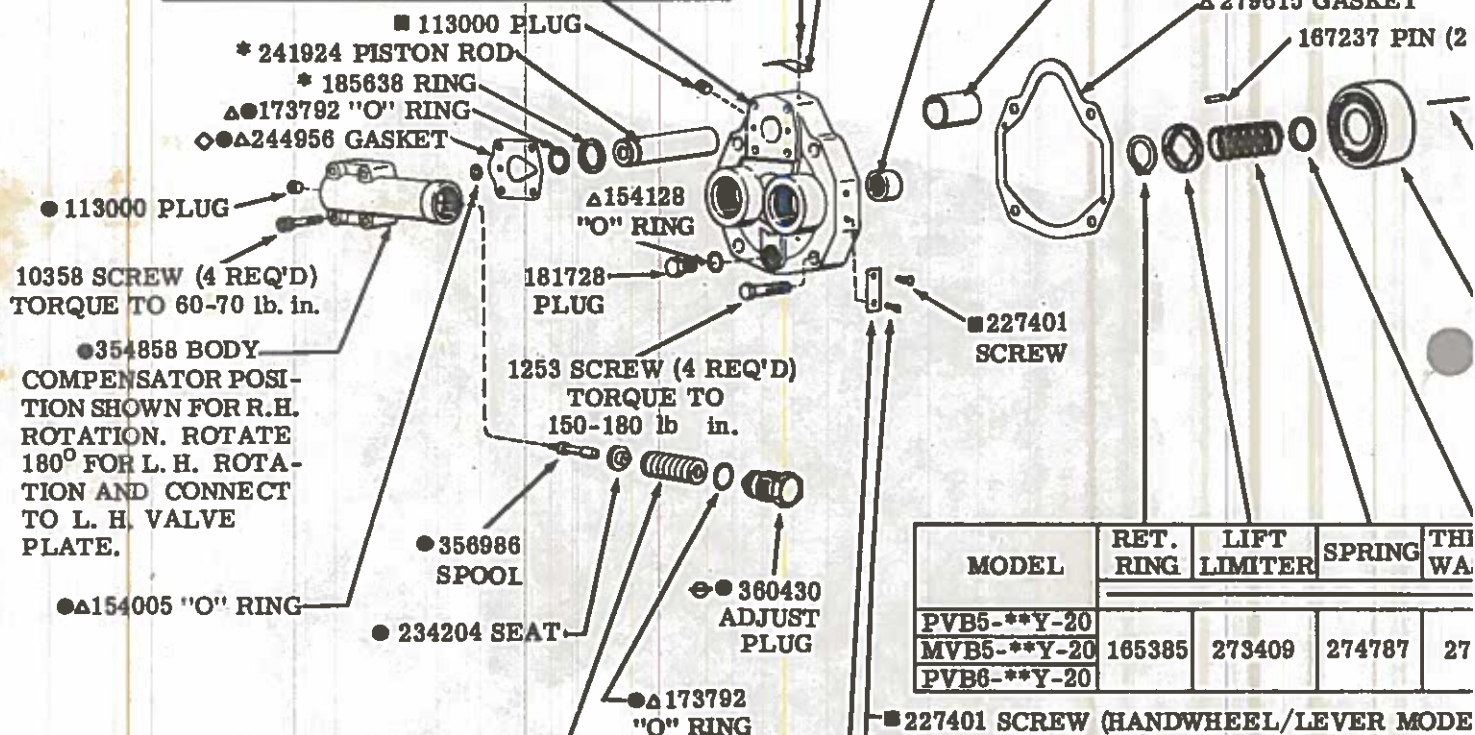
317572
BEARING
(REF.)

CAUTION
DO NOT ALLOW SEALING COMPOUND
TO CONTACT THE BEARING NEEDLES.

BEARING

MODEL	VALVE PLATE S/A
PVB*-RSY-20-C(*)-11	942223
PVB*-LSY-20-C(*)-11	942224
PVB*-RDY-20-H/M-10	942225
PVB*-LDY-20-H/M-10	942246
MVB5-UDY-20-H/M-10	942227

MODEL
PVB*-SY-20-C



PRESSURE RANGE (PSI)	COMPENSATOR SUBASSY	SPRING
(C)250-3000 (5)	942158	239371
Φ 250-2000 (6)		
(CM)250-1500	942159	265693

● INCLUDED IN PRESSURE
COMPENSATOR SUBASSYS
SHOWN IN TABLE.

■ INCLUDED IN
VALVE PLATE S/A

MODEL	RET. RING	LIFT LIMITER	SPRING	THI WA.
PVB5-***Y-20				
MVB5-***Y-20	165385	273409	274787	27
PVB6-***Y-20				

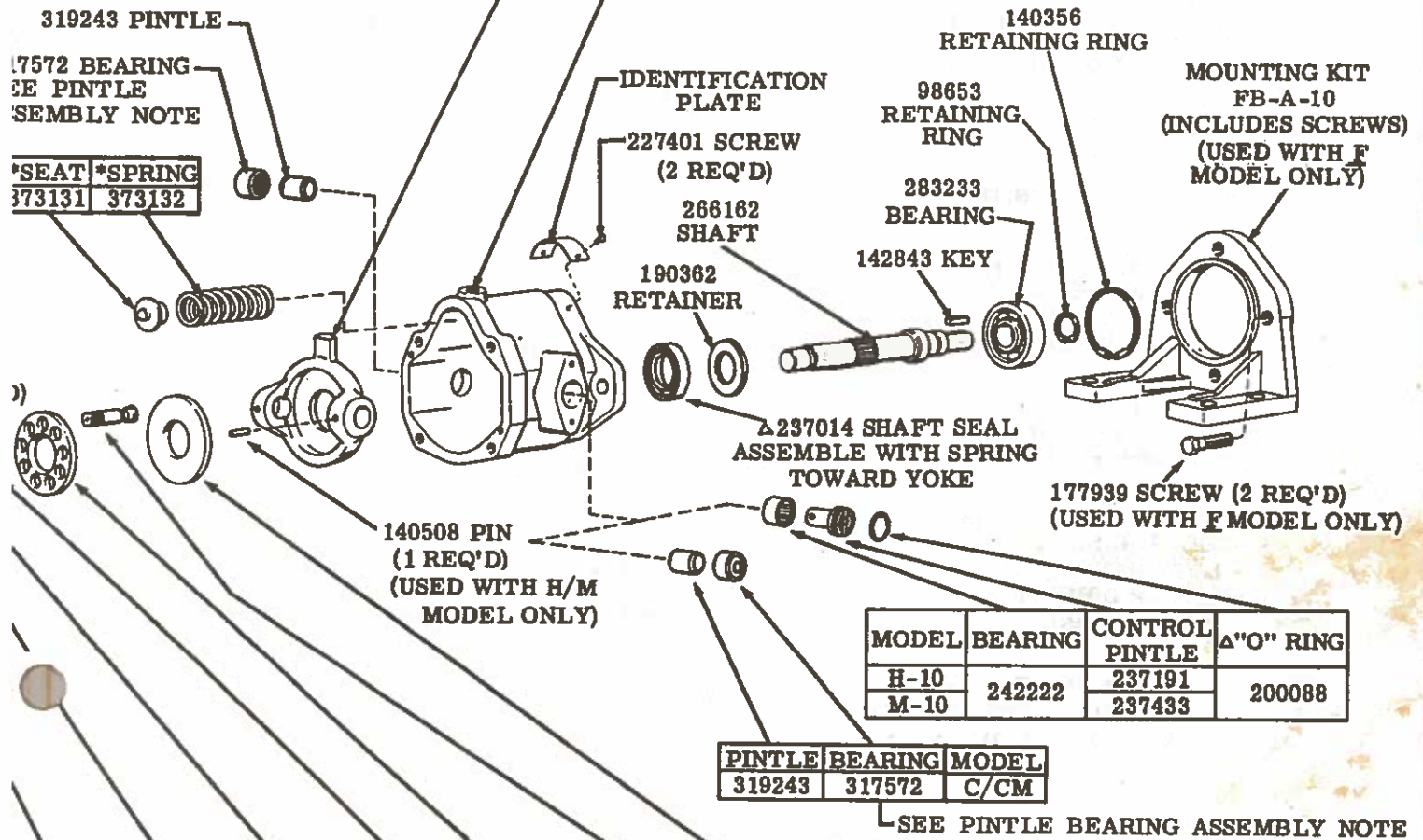
■ 227401 SCREW (HANDWHEEL/LEVER MODE)
■ 227407 SCREW (COMPENSATOR MODELS)
ROTATION PLATE
■ 404751 - COMPENSATOR PUMP MODELS
■ 195060 - HANDWHEEL & LEVER PUMP MC

⊕ **CAUTION**
MODEL PVB6 COMPENSATOR
PRESSURE ADJUSTMENT SHALL
NOT EXCEED 2000 PSI.

**NOTE: COMPENSATOR
CONTROL SHOWN. FOR
MANUAL CONTROLS SEE
BACK PAGE**

MODEL	YOKE	HOUSING
PVB*-D*Y-20-H-1*	237192	436462
PVB*-D*Y-20-M-1*		308334
PVB*-S*Y-20-C(*)-1*	231557	

⚠CAUTION
POSITION GASKET WITH SMALL END
OF TEARDROP HOLE POINTING IN
DIRECTION OF COMPENSATOR ADJ-
USTING PLUG.



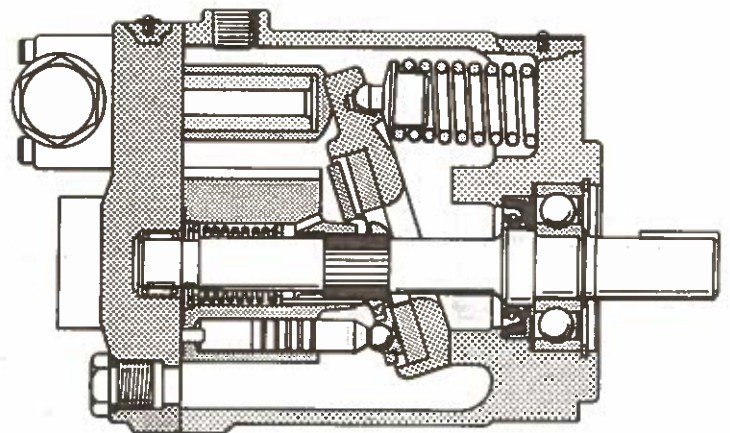
CYL. BLOCK	PIN (3 REQ'D)	WASHER	SPHER. WASHER	SHOE PLATE	PISTON S/A KIT	SWASH PLATE	ROTATING GROUP KIT
THESE PARTS INCLUDED IN							
274670					942229		938262
316000	248203	274956	275485	274249		319245	938265
315148					942230		938264

F3 EQUIVALENT
SEAL KIT 919308

PISTON S/A KIT
INCLUDES 9
PISTON S/A

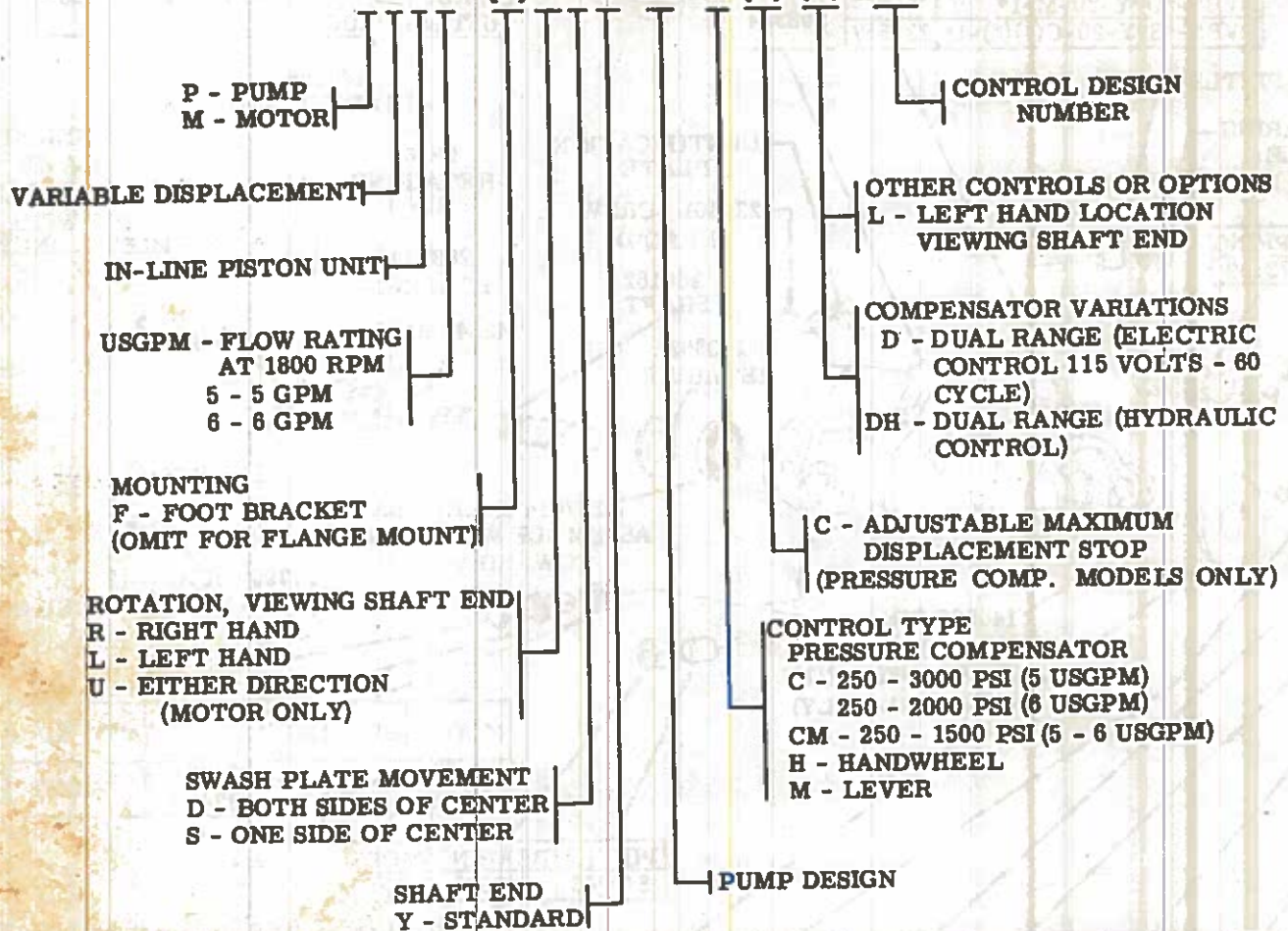
*USED WITH COMPENSATOR
CONTROL ONLY

ΔINCLUDED IN
919191 SEAL KIT

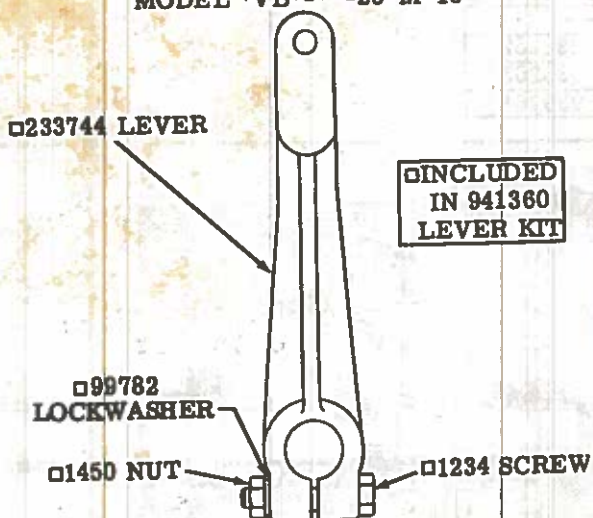


MODEL CODE BREAKDOWN

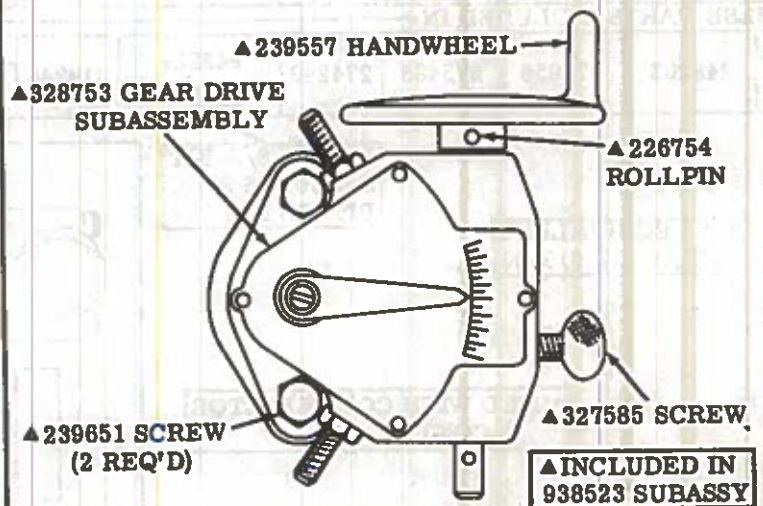
VB - (F) ** Y - 20 - * (*) (*) - 1*



MANUAL LEVER CONTROL
MODEL *VB*-**-20-M-10



HANDWHEEL CONTROL
MODEL *VB*-**-20-H-10



For satisfactory service life of these components in industrial applications, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFF, OFR, and OFRS series are recommended.

Litho in U. S. A.

COURSE REVIEW

(100 Questions, Answer Either True or False)

· TRUE FALSE

Pressure in a hydraulic system at all times is determined by:

- | | A | B | |
|---|---|---|---|
| 1 | (☒) | (☒) | The path of greatest resistance to flow. |
| 2 | (☒) | (☐) | The path of least resistance to flow. |
| 3 | (☒) | (☒) | The pressure setting of the relief valve. |

Where a restriction is used in a hydraulic circuit:

- | | A | B | |
|---|---|---|---|
| 4 | (☒) | (☐) | A pressure drop exists while there is flow. |
| 5 | (☒) | (☒) | Pressure drop across the restriction is affected by the viscosity of the fluid. |
| 6 | (☐) | (☒) | Flow rate remains constant regardless of the pressure drop, fluid temperature or viscosity. |

The hydraulic fluid used:

- | | A | B | |
|---|---|---|--|
| 7 | (☒) | (☐) | Should be continuously filtered. |
| 8 | (☒) | (☐) | Should contain additives to inhibit rust and corrosion and provide antiwear protection |
| 9 | (☒) | (☒) | Tends to seal clearances in pumps and valves. |

$$F = P \times A$$

The area of the cap end of a cylinder piston:

- | | A | B | |
|----|---|---|---|
| 10 | (☒) | (☒) | Can be determined by the formula $A = D^2 \times .7854$. |
| 11 | (☐) | (☒) | Will have no bearing on the speed of the piston. |
| 12 | (☒) | (☐) | Will affect the force obtainable. |

The speed of a hydraulic cylinder can be changed by:

- | | A | B | |
|----|---|---|--|
| 13 | (☒) | (☐) | Varying the displacement of the pump. |
| 14 | (☒) | (☐) | Changing the speed of the drive shaft of the pump. |
| 15 | (☒) | (☒) | Increasing or decreasing the force opposing it (ignoring leakage). |

Hydraulic motors:

- | | A | B | |
|----|---|------------------------------|---|
| 16 | (☒) | (☐) | Can be used in closed loop hydraulic systems. |
| 17 | (☒) | (☐) | Should not be reversed under load. |

T = Fxd

TRUE FALSE

Fixed displacement hydraulic motors:

- | | A | B | |
|----|---|---|---|
| 18 | () | (☒) | Increase their output torque capability with an increase in RPM. |
| 19 | (☒) | () | Increase their output horsepower with an increase in RPM. (Constant load.) |
| 20 | (☒) | () | Are capable of constant torque regardless of speed. |
| 21 | (☒) | () | Output torque is determined by the workload up to the relief valve setting. |
| 22 | () | (☒) | Will be damaged if stalled by the load. |

Variable displacement piston type motors:

- | | A | B | |
|----|---|---|--|
| 23 | (☒) | () | May be pressure compensated. |
| 24 | () | (☒) | Should not be operated too near their center position. |
| 25 | (☒) | () | Increase driveshaft speed as the angle of the yoke is decreased. |
| 26 | (☒) | () | Increase torque capability as the angle of the yoke is decreased.. |

Directional valves:

- | | A | B | |
|----|---|---|--|
| 27 | (☒) | () | Are frequently pilot operated. |
| 28 | (☒) | () | Can provide a means of unloading the pump when in neutral. |
| 29 | () | (☒) | Should never be connected in parallel. |
| 30 | (☒) | (☒) | Should never be connected in series. |
| 31 | (☒) | () | Are available in many center condition types |

A servo valve system:

- | | A | B | |
|----|---|---|--|
| 32 | (☒) | () | Can control the position or speed of the actuator. |
| 33 | () | (☒) | Does not require fine filtration. |

Vickers balanced piston type relief valves may be used for:

- | | A | B | |
|----|---|---|--|
| 34 | (☒) | () | Limiting the force exerted by a cylinder or the torque exerted by a hydraulic motor. |
| 35 | (☒) | () | Limiting the maximum system pressure. |
| 36 | () | (☒) | Unloading the pump by "venting". |

TRUE FALSE

Pressure reducing valves are used to:

- | | A | B | |
|----|---|---|---|
| 37 | (☒) | (☒) | Limit their maximum inlet pressure. |
| 38 | (☒) | () | Limit maximum pressure in a branch circuit. |
| 39 | () | (☒) | Limit their minimum outlet pressure. |

An unloading valve is correctly applied if:

- | | A | B | |
|----|---|---|--|
| 40 | (☒) | (☒) | It can be opened fully by the external pressure source. |
| 41 | (☒) | (☒) | Little or no pressure remains at the large volume pump outlet. |
| 42 | (☒) | () | Its external pilot pressure connection is open to tank. |
| 43 | () | (☒) | Its pressure setting is at least 150 psi below the relief valve setting. |

Sequence valves are used to:

- | | A | B | |
|----|---|---|--|
| 44 | (☒) | (☒) | Assure that one operation occurs before another. |
| 45 | () | (☒) | Limit the maximum pressure on the secondary operation. |
| 46 | (☒) | () | Hold a predetermined minimum pressure in the primary line while the second operation is in motion. |
| 47 | () | () | Should be externally drained. |

Counterbalance valves:

- | | A | B | |
|----|---|-----|---|
| 48 | (☒) | () | Impose a hydraulic resistance on a cylinder or motor. |
| 49 | (☒) | () | Prevent a piston from moving ahead of the oil supply. |
| 50 | (☒) | () | Are internally drained. |
| 51 | (☒) | () | Prevent a load from falling. |

In a poppet type cartridge valve system:

- | | A | B | |
|----|---|-----|--|
| 52 | (☒) | () | Pilot pressure is required to open the valve when used in a directional control application. |
| 53 | (☒) | () | The cartridge valve may control direction of flow, rate of flow, or max system pressure. |
| 54 | (☒) | () | Internal system leakage will be higher than a spool type directional valve system. |

TRUE FALSE

To insure correct operation of the restrictor type flow control valve (FCG):

- | | A | B | |
|----|-----|-----|--|
| 55 | (✓) | () | The outlet port must be open to the tank. |
| 56 | (✓) | () | The flow rate setting must be less than the oil supply rate to the valve. |
| 57 | (✓) | () | The relief valve should be set high enough to maintain at least a 150 psi difference between the inlet and the outlet ports. |

A "meter-in" circuit may be used:

- | | A | B | |
|----|-----|-----|---|
| 58 | (✓) | () | For regulating the rate of oil flow to the load. |
| 59 | (✓) | (✓) | To control over-running loads. |
| 60 | (✓) | () | Where accurate feed rates are required with opposing loads. |

A "meter-out" circuit may be used:

- | | A | B | |
|----|-----|-----|--|
| 61 | (✓) | () | For over-running loads. |
| 62 | (✓) | () | For regulating the flow of exhaust oil from the load. |
| 63 | (✓) | () | Where it is desirable to prevent a jump when tools break through the work. |

A "bleed-off" circuit may be used:

- | | A | B | |
|----|-----|-----|--|
| 64 | (✓) | () | Where accurate feed rates are required. |
| 65 | (✓) | () | For over-running loads. |
| 66 | (✓) | () | To conserve horsepower where feed rates are not very critical. |
| 67 | (✓) | () | For diverting some of the pump delivery to the tank. |

Advantages of the by-pass type flow control with integral relief valve are as follows:

- | | A | B | |
|----|-----|-----|--|
| 68 | (✓) | () | It will prevent a cylinder from moving ahead of the oil supply. |
| 69 | () | (✓) | Pressure at the pump is approximately 20 PSI higher than load pressure. |
| 70 | () | (✓) | When installed in the pump outlet line, It usually eliminates the need for a separate pressure relief valve. |
| 71 | (✓) | () | It may be vented to unload the pump during periods of idleness. |

TRUE FALSE

A defective shaft packing or seal of an internally drained vane pump may: (pump is above reservoir)

- | | A | B | |
|----|-----|-----|--------------------------------------|
| 72 | (✓) | () | Make the system operate erratically. |
| 73 | (✓) | () | Let in air and make the pump noisy. |

Power required to drive a fixed displacement pump:

- | | A | B | |
|----|-----|-----|---|
| 74 | (✓) | () | Will increase as pump leakage increases. |
| 75 | (✓) | () | Varies with the operating pressure. |
| 76 | () | (✓) | Remains constant under varying workloads. |
| 77 | (✓) | () | Is a function of pump GPM and operating pressure. |

Pumps used in power hydraulic systems:

- | | A | B | |
|----|-----|-----|----------------------------------|
| 78 | (✓) | () | Are positive displacement pumps. |
| 79 | (✓) | () | May be variable displacement. |
| 80 | (✓) | () | May be fixed displacement. |
| 81 | () | (✓) | Are always externally drained. |

Restriction of the pump inlet may:

- | | A | B | |
|----|-----|-----|---|
| 82 | (✓) | () | Make the pump noisy. |
| 83 | (✓) | () | Be caused by a dirty intake strainer. |
| 84 | (✓) | () | Result in cavitation and unnecessary pump wear. |

Vickers high performance "intra-vane" (VHO) pumps:

- | | A | B | |
|----|-----|-----|---|
| 85 | () | (✓) | Do not have system pressure under the entire vane at all times. |
| 86 | (✓) | () | Require rearrangement of cartridge parts for reversal of shaft rotation. |
| 87 | (✓) | (✓) | Are not available in double pump construction. |
| 88 | (✓) | () | Have holes in each rotor segment to equalize the pressure on the top and bottom of the vanes. |

Piston type pumps:

- | | A | B | |
|----|-----|-----|---|
| 89 | (✓) | () | Should have the housing filled with oil before starting. |
| 90 | (✓) | () | Vickers "B" series inline pumps must be externally drained. |
| 91 | (✓) | () | May be pressure compensated. |

TRUE FALSE

The R valve used as a brake valve:

- | | A | B | |
|----|---|---|--|
| 92 | (☒) | () | Must be externally drained. |
| 93 | () | (☒) | Is both externally and internally operated. |
| 94 | (☒) | () | Prevents a cylinder or motor from running ahead of the oil supply. |

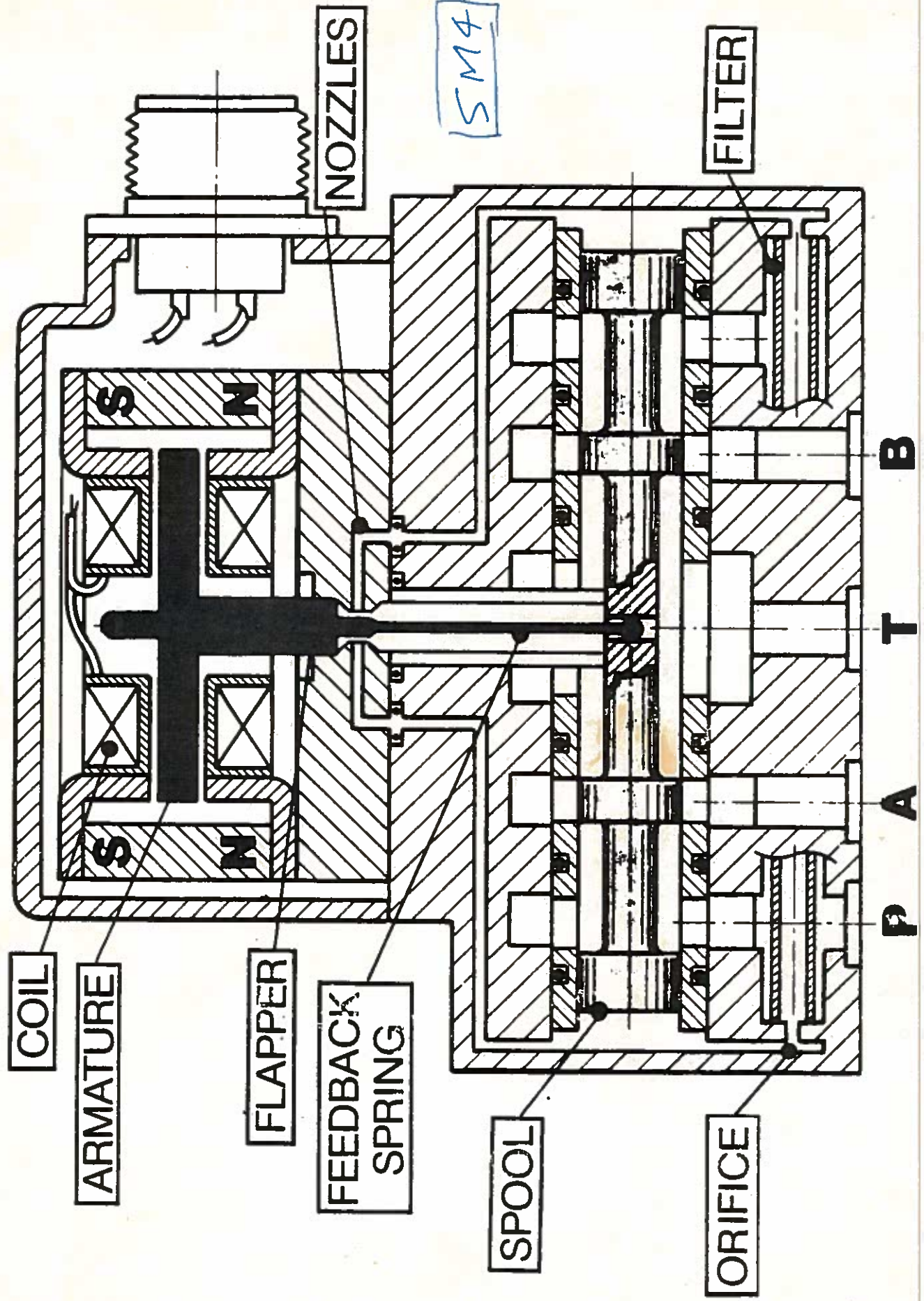
Flow direction through a variable displacement piston pump is affected by:

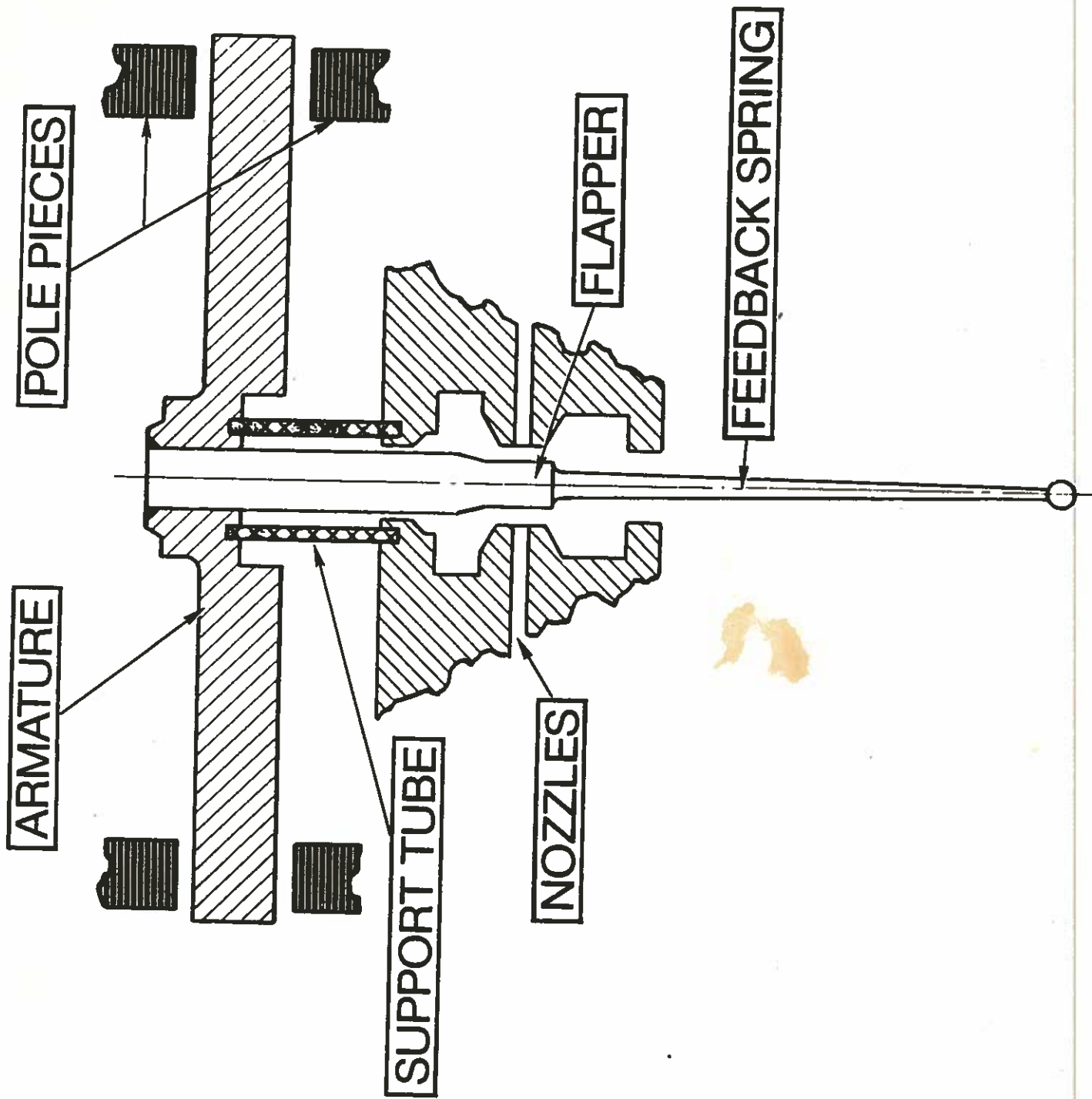
- | | A | B | |
|----|---|--------|--|
| 95 | (☒) | () | Direction of drive shaft rotation. |
| 96 | (☒) | () | Angle of yoke displacement.(One side of center.) |
| 97 | (☒) | () | Shifting yoke across center. |

Vickers Hydraulic Adjustable Speed Drives:

- | | A | B | |
|-----|---|---|--|
| 98 | (☒) | () | Are complete self-contained hydraulic systems. |
| 99 | (☒) | () | Contain replenishing pumps to assure an adequate supply of oil to the main pump. |
| 100 | () | (☒) | Do not have relief valves because the pump is variable displacement. |

STATE-OF-THE-ART SERVO VALVE





ПЕРВЫЙ СЫН

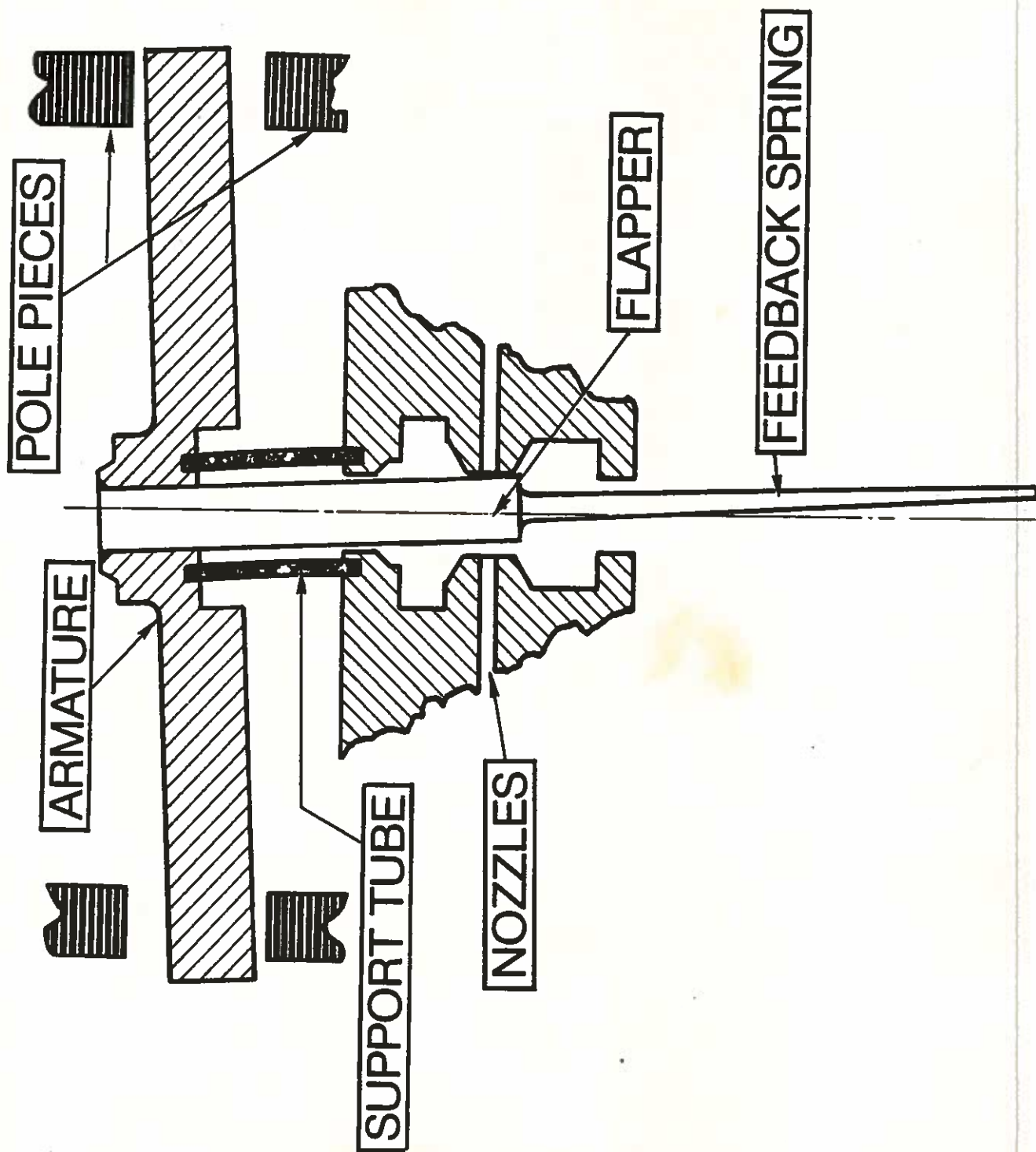
ПЕРВЫЙ

ПЕРВЫЙ

ПЕРВЫЙ

ПЕРВЫЙ

ПЕРВЫЙ



INPUT
(+)

INPUT
(-)

CONTROL
(-)

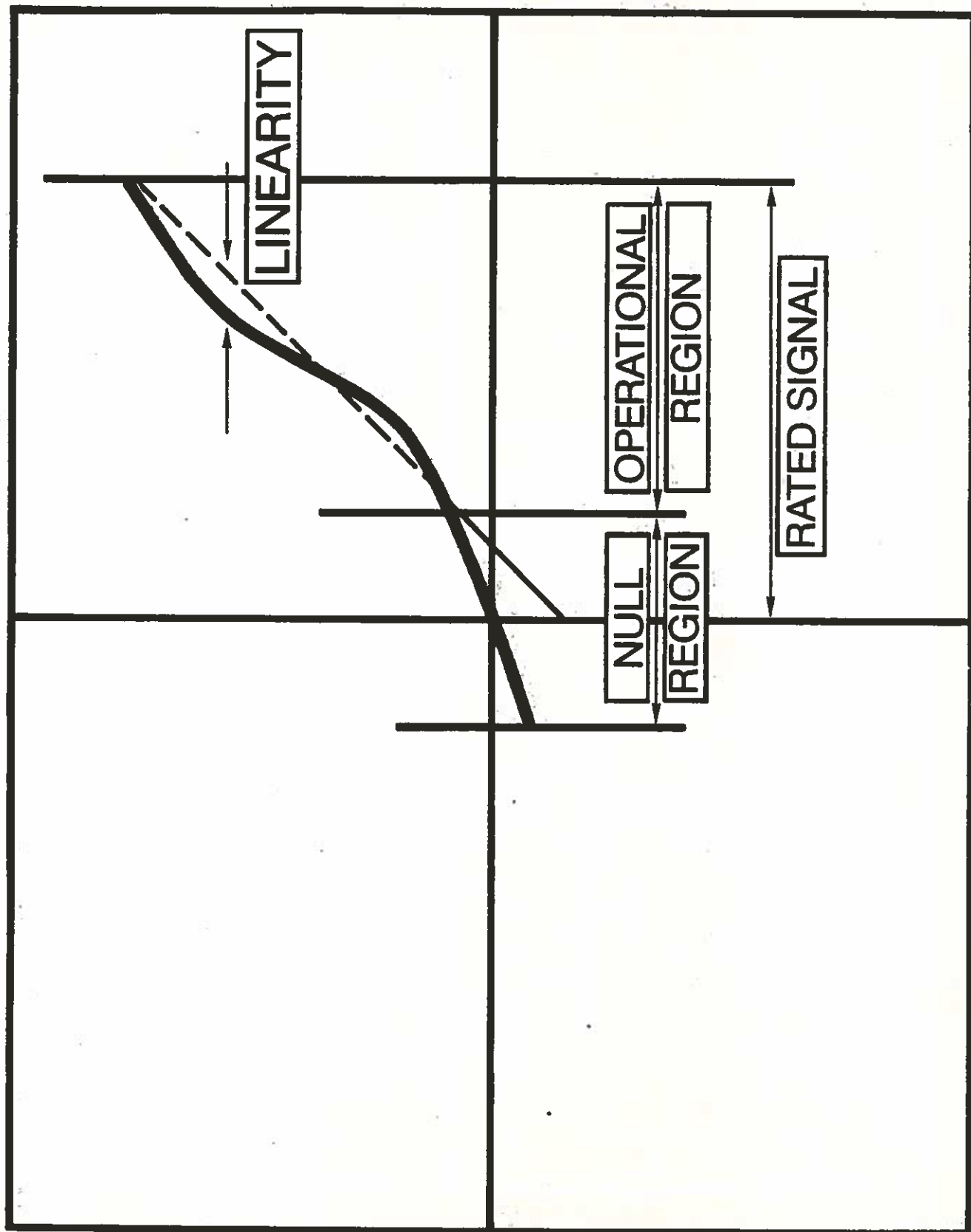
INPUT
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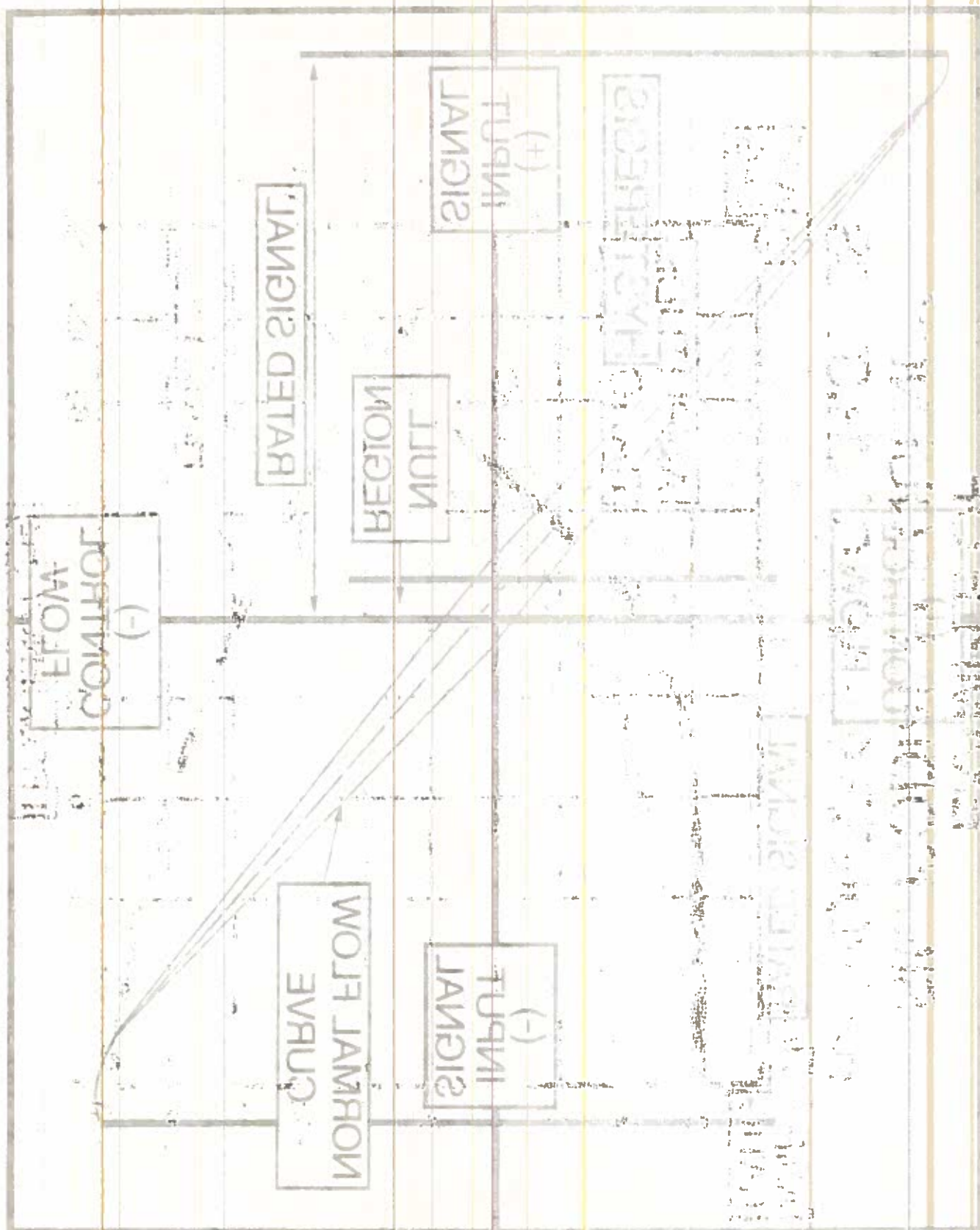
INPUT
(+)

INPUT
(+)

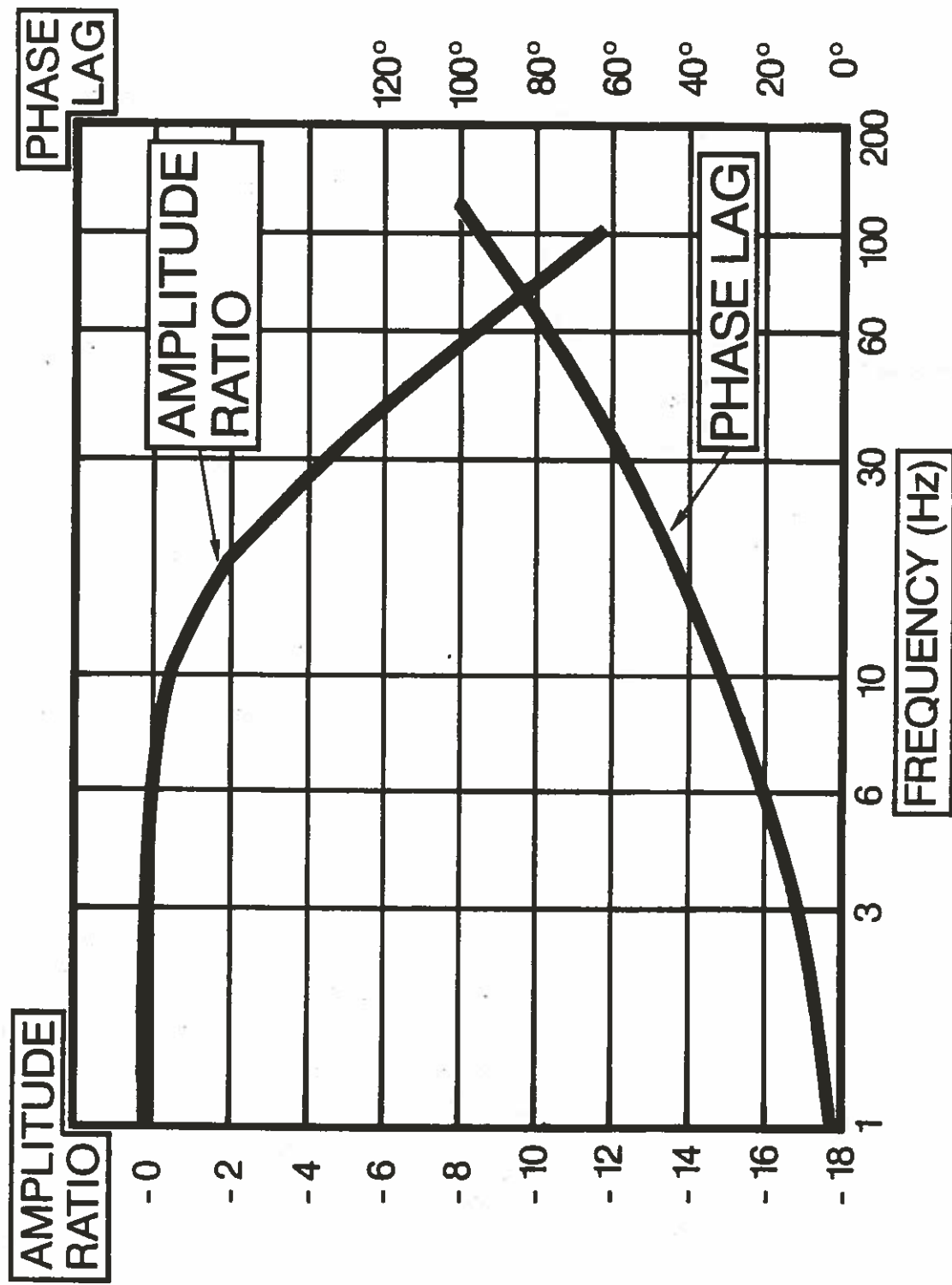
NOTHING

LINEARITY

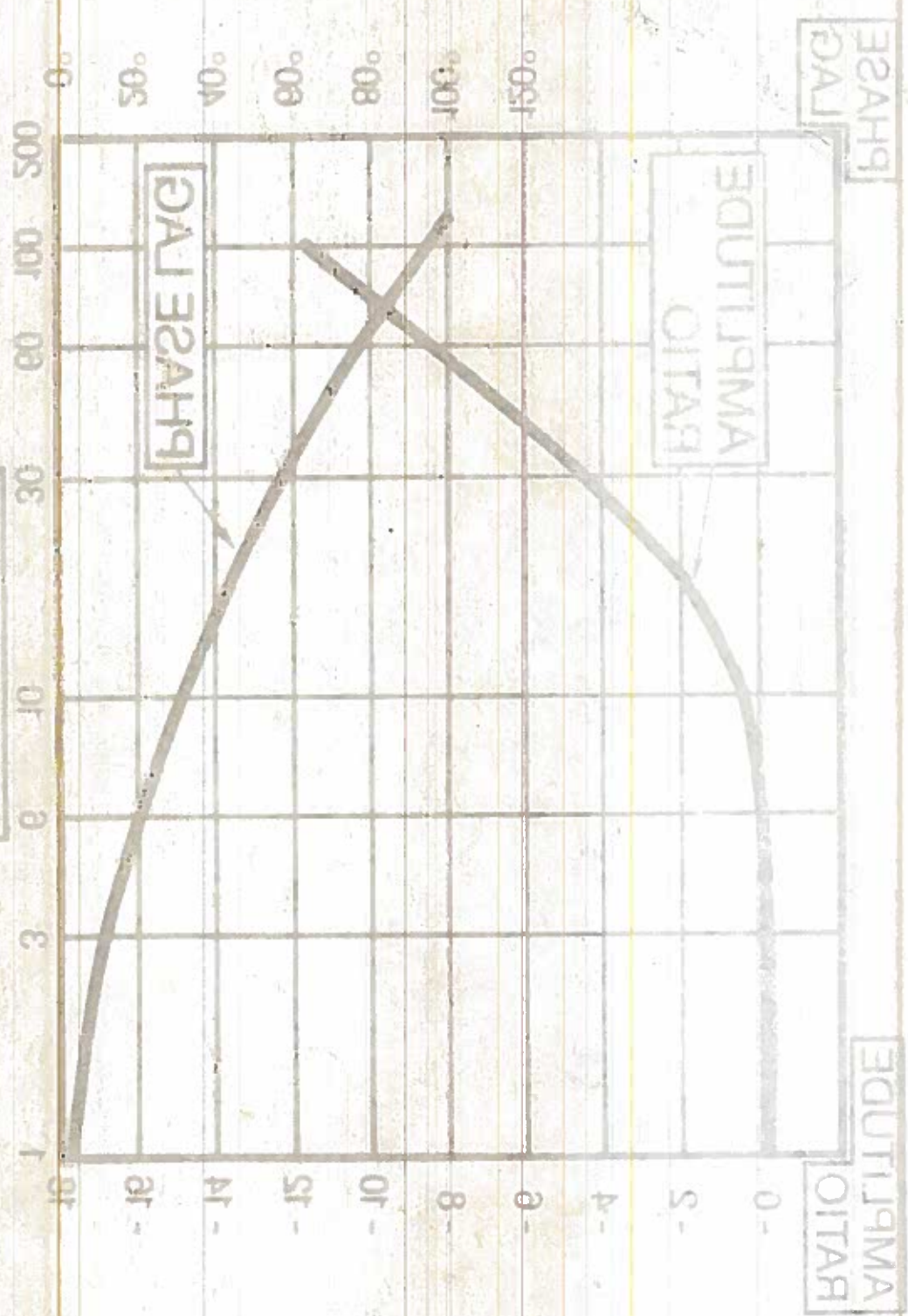




EXAMPLE OF SINUSODIAL FREQUENCY RESPONSE CHARACTERISTICS



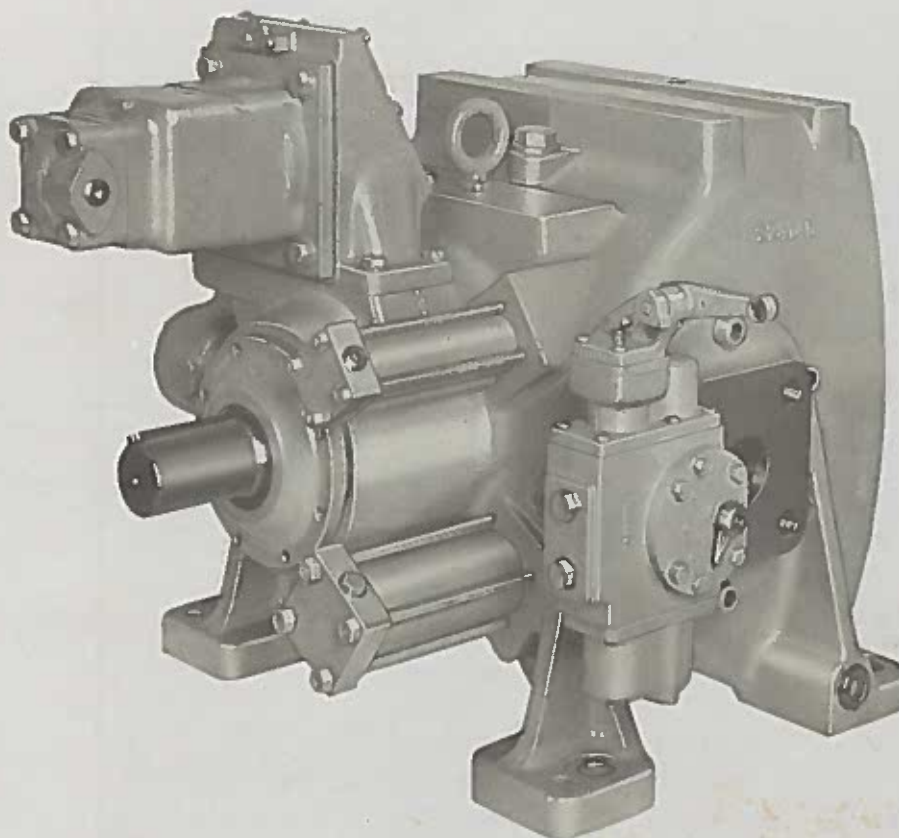
ТО ЭЛГМАХЭ ҮСНЭУОЛЕРТ ЛАГОЗУИЛ ЗОЛТЗІАЛТАРАНО ЭСИОПЗЭР



Service Parts Information

**Variable
Displacement
Piston
Pumps &
Motors**

PVA150-**-10/11/12/13/14
MVA150-**-10/11/12/13/14



Vickers, Incorporated

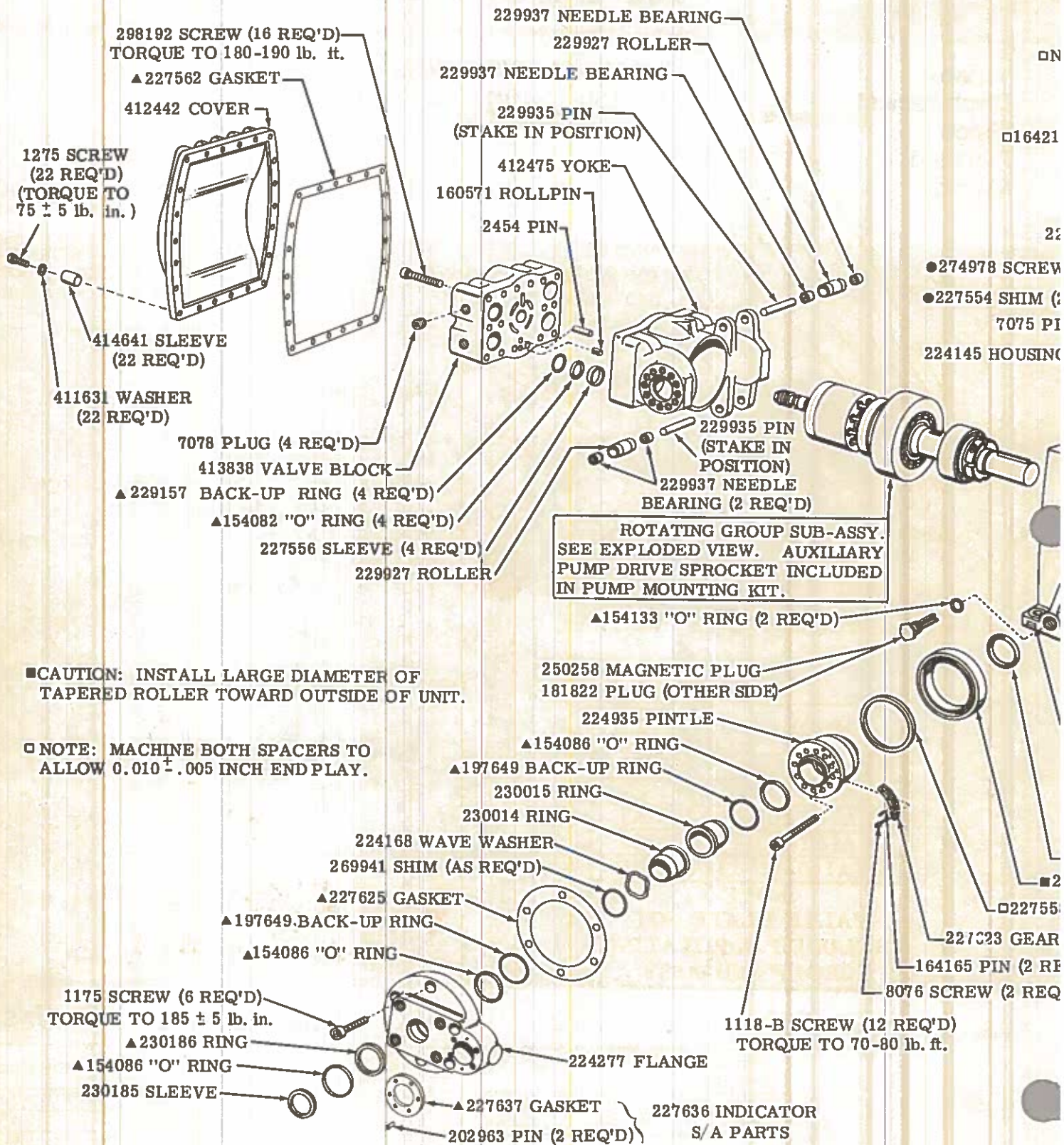
1401 Crooks Road
Troy, Michigan 48084

Revised 7-1-86

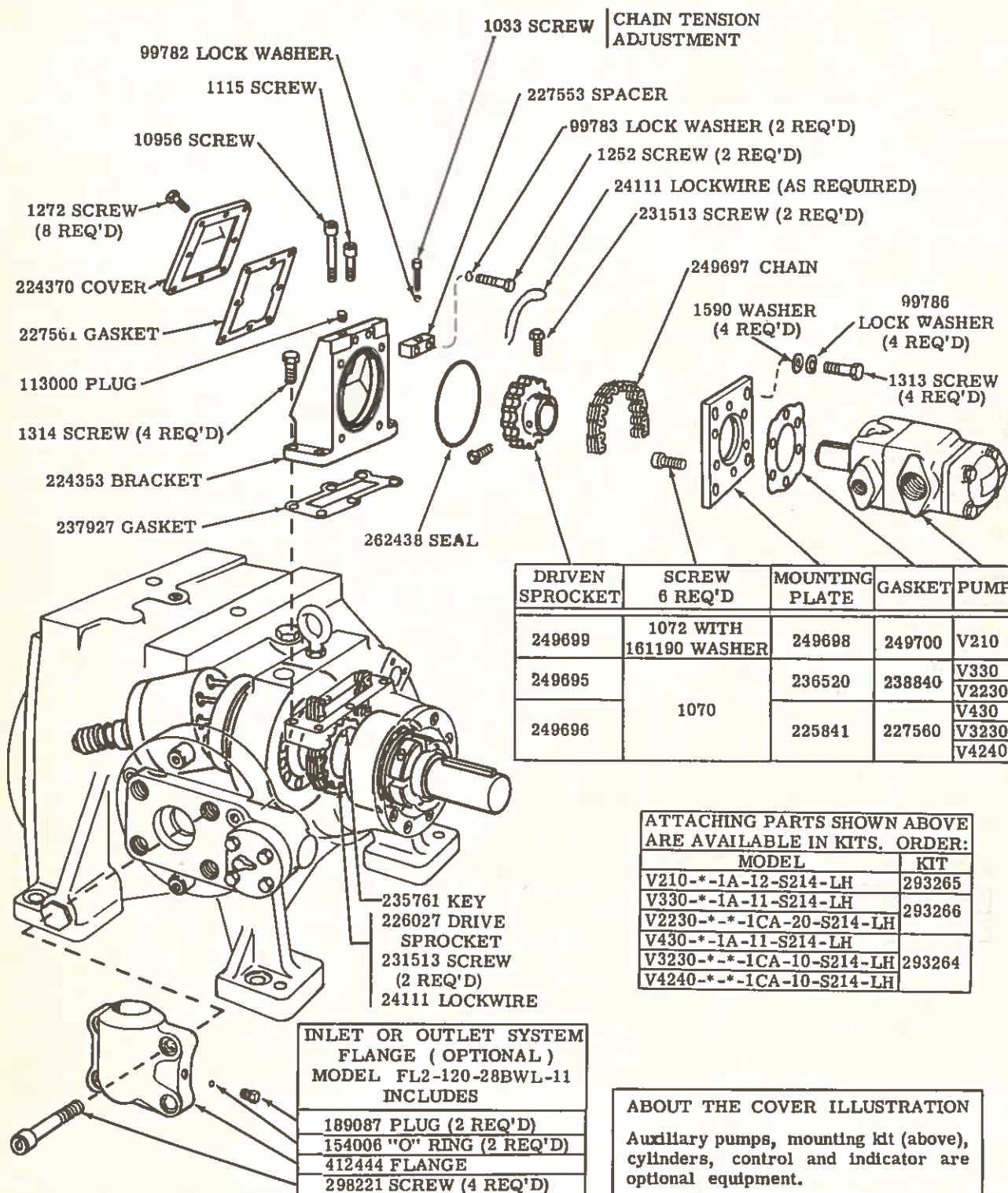
I-3207-S

PVA150-**-10/11/12/13/14

MVA150-**-10/11/12/13/14



AUXILIARY PUMPS: ATTACHING PARTS & SYSTEM FLANGES



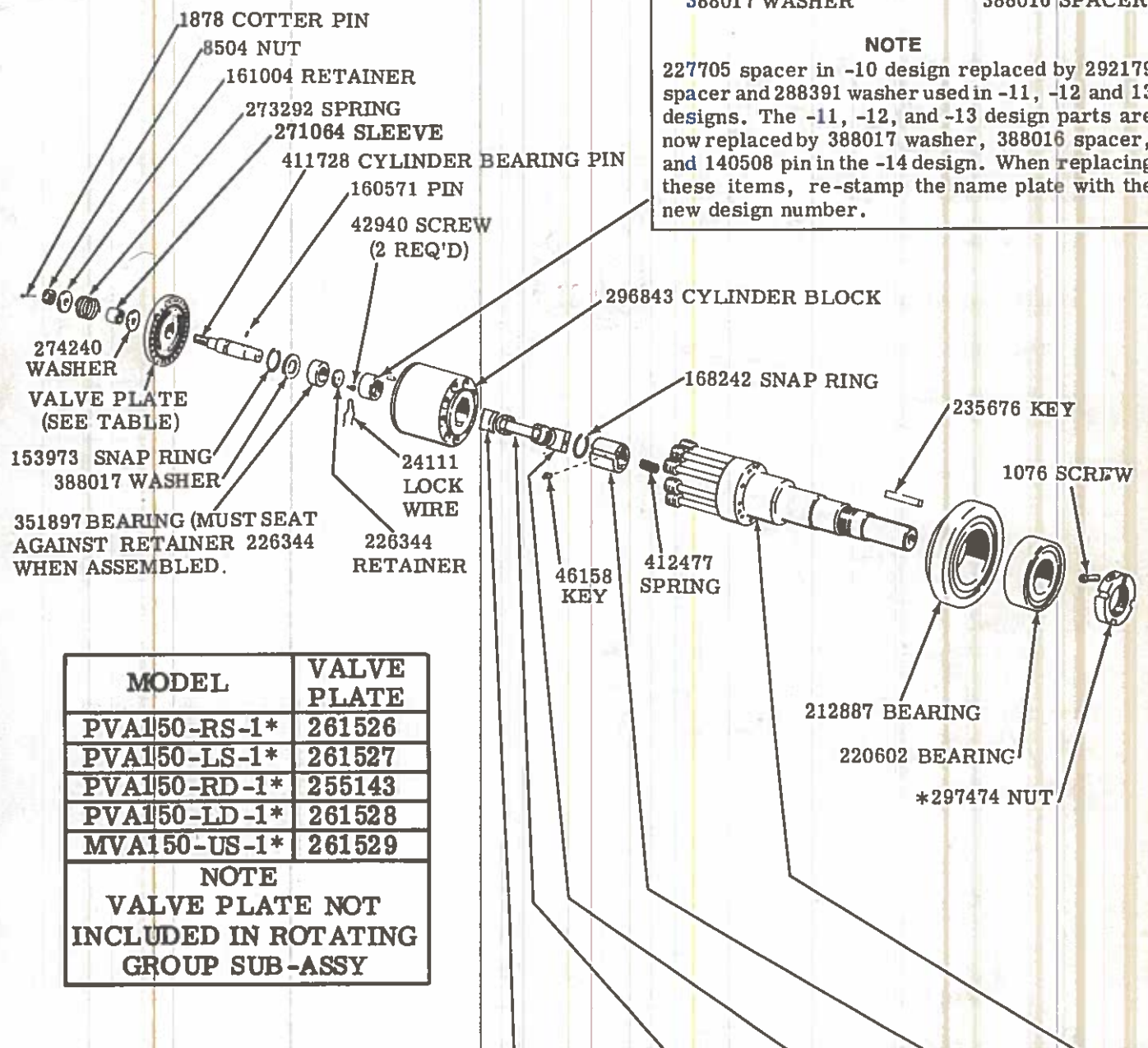
ATTACHING PARTS SHOWN ABOVE ARE AVAILABLE IN KITS. ORDER:

MODEL	KIT
V210--1A-12-S214-LH	293265
V330--1A-11-S214-LH	293266
V2230--*-1CA-20-S214-LH	
V430--1A-11-S214-LH	293264
V3230--*-1CA-10-S214-LH	
V4240--*-1CA-10-S214-LH	

ABOUT THE COVER ILLUSTRATION

Auxiliary pumps, mounting kit (above), cylinders, control and indicator are optional equipment.

ROTATING GROUP SUBASSEMBLY EXPLODED VIEW



DESIGN NUMBER	ROTATING GROUP	BEARING	UNIV. LINK & PIN	BEARING	RETAINER	SHAFT S/A
10, 11, 12	*	220162	220161	220162	220163	255145
13/14	938070	410260	349456	341841	388015	350750

***USE ROTATING GROUP 938070 TO SERVICE -10, -11, -12, -13, & -14 DESIGN UNITS.**

F3 EQUIVALENT SEAL KIT 919619
(CONTAINS F3 "O" RINGS & GAS-
KETS FOR DESIGNS -10 THRU -14.
DOES NOT CONTAIN F3 ROTOR &
STATOR SEALS.)

ED WITH
LARY
OPTION

EW (6 REQ'D)

38 COVER

YE BOLT

(Q'D)

D)

23746 ROTATION PLATE

3X-36212 SCREW (2 REQ'D)

45682 INSTRUCTION PLATE

1725-X SCREW (2 REQ'D)

NAMEPLATE

152416 SCREW (4 REQ'D)

3935 PLATE (2 REQ'D)

725-X SCREW (4 REQ'D)

55 "O" RING

BEARING

ER

OR

THESE PARTS MAY BE ON OPPOSITE PINTLE

DEPENDING ON CONTROL ASSEMBLY. LO-

CATION FOR R. H. ROTATION SHOWN.

NOTE

ASSEMBLE 274978 SCREWS INTO HOUSING WITHOUT

SHIM 227554. ADJUST SCREWS TO LIMIT YOKE TRAVEL

AT 30°(+1/2°-0°). MEASURE GAP BETWEEN SCREW

AND HOUSING. GRIND THE SHIMS TO THIS DIMENSION

±.005. APPLY VICKERS SEALANT 367410 TO SCREW

THREADS AND INSTALL THE SCREWS THROUGH THE

SHIMS INTO THE HOUSING.

230185 SLEEVE

▲154086 "O" RING

▲230186 RING

1175 SCREW (6 REQ'D)

TORQUE TO 185 ± 5 lb. in.

THIS FLANGE PART

OF CONTROL ASS'Y.

▲154086 "O" RING

▲197649 BACK-UP RING

269941 SHIM (AS REQ'D)

224168 WAVE WASHER

230014 RING

230015 RING

1118-B SCREW (12 REQ'D)

TORQUE TO 70-80 lb. ft.

224935 PINTLE

□ 227558 SPACER

■ 266397 BEARING

▲237927 GASKET

▲200155 "O" RING

*297634 SPRING (4 REQ'D)

*231069 PIN (4 REQ'D)

*297472 SEAL (ROTOR)

▲*262411 "O" RING

*297473 SEAL (STATOR)

▲*262419 "O" RING

*226035 GASKET

*297475 SEAL RETAINER

*1050 SCREW (8 REQ'D)

⊕ USED ON STD -10/-11/-12/-13 DESIGNS.

FOR F3 FLUID APPLICATIONS, CON-

VERT TO SEAL ARRANGEMENT SHOWN

ABOVE. (KIT 942319)

⊕ 1050 SCREW (8 REQ'D)

⊕ 226043 RETAINER (STD. SEAL)

⊕ 265682 SHAFT SEAL

⊕ 226035 GASKET

▲ INCLUDED IN
919188 SEAL KIT

*942319 FACE TYPE SHAFT SEAL
CONVERSION KIT. (INCLUDES ALL
PARTS NECESSARY FOR INSTAL-
LATION INTO A 10, 11, 12, OR 13
DESIGN UNIT. -14 DESIGNS USE THE
FACE TYPE SEAL AS STANDARD.)

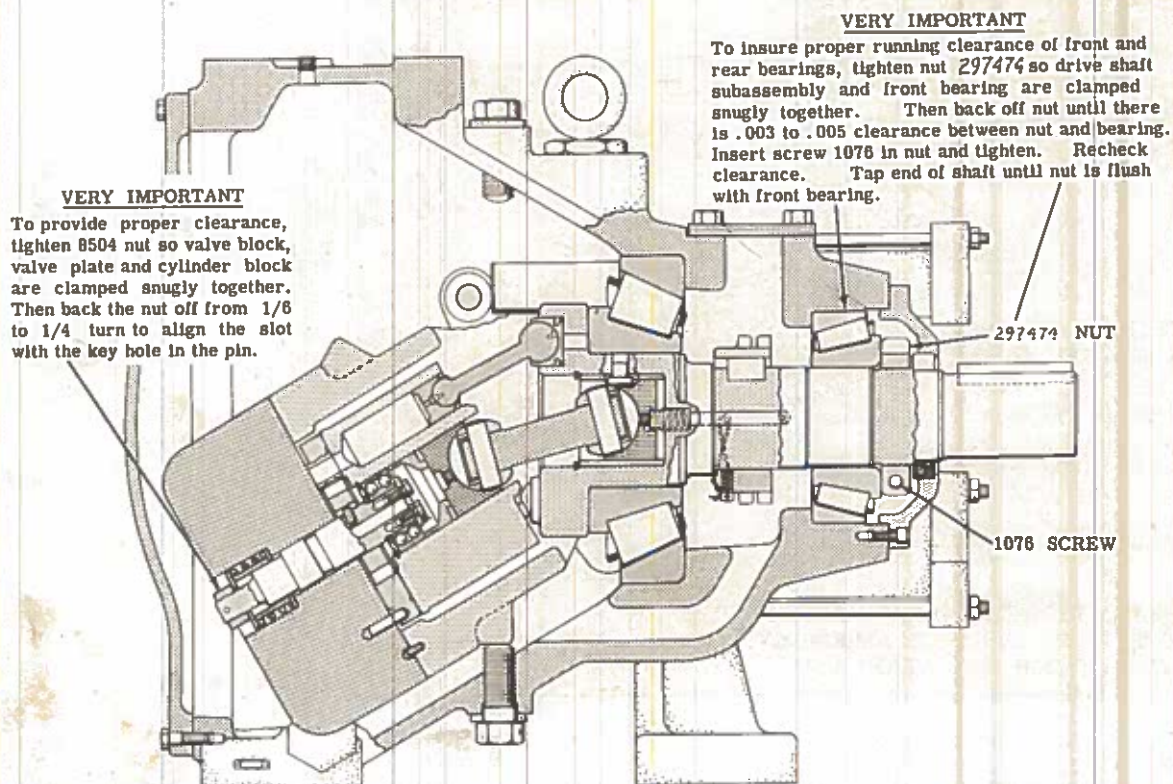
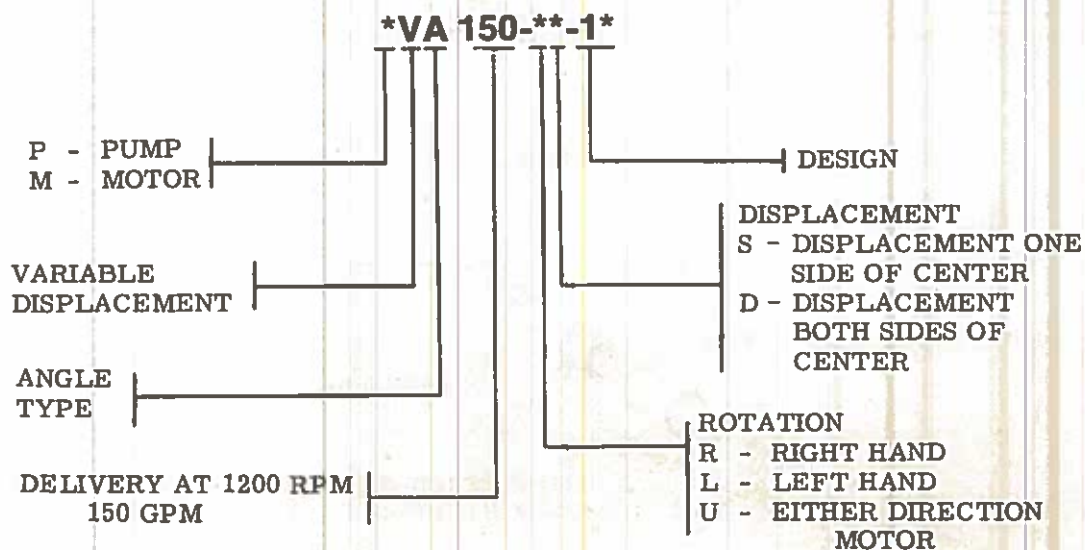
CONTROLS

COMPENSATOR CONTROL PARTS
SHOWN ON I-3210-S AND I-3211-S.

HYDRO-MECHANICAL CONTROL
PARTS SHOWN ON I-3214-S.

ELECTRO HYDRAULIC SERVO
CONTROL PARTS SHOWN ON
I-3206-S.

MODEL CODE BREAKDOWN



For satisfactory service life of these components, use full flow filtration to provide fluid which meets ISO cleanliness code 16/13 or cleaner. Selections from Vickers OFP, OFR, and OFRS series are recommended.

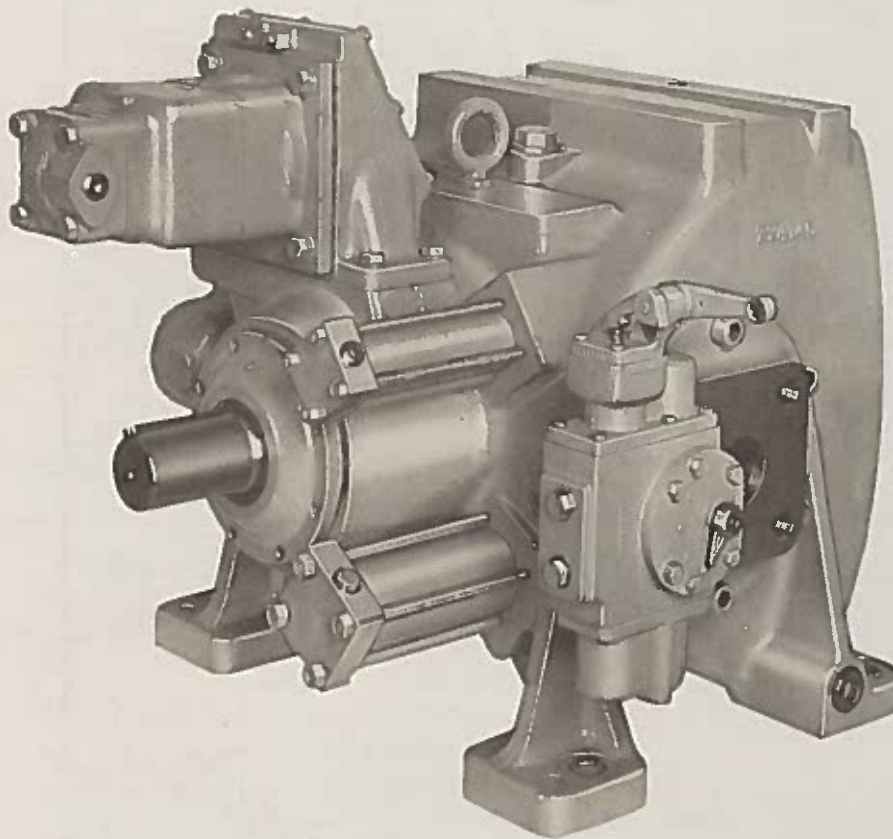
LITHO IN U. S. A.

VICKERS

Service Parts Information

**Variable
Delivery
Piston
Pumps &
Motors**

PVA120-**-10/11/12/13/14
MVA120-**-10/11/12/13/14



Vickers, Incorporated

1401 Crooks Road
Troy, Michigan 48064

Revised 7-1-86

I-3205-S

PVA120-**-10/11/12/13/14

MVA120-**-10/11/12/13/14

